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The Burroughs Wellcome Fund
is an independent private foundation
dedicated to advancing the medical sciences
by supporting research
and other scientific and educational activities.

1999

ANNUAL REPORT

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WELLCOME
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CONTENTS

ABOUT THE BURROUGHS WELLCOME FUND 2

REPORT FROM THE PRESIDENT 3

GENERATING NEW MEDICAL KNOWLEDGE: CLINICAL SCIENTIST AWARDS IN TRANSLATIONAL RESEARCH 11

UNDERSTUDIED INFECTIOUS DISEASES: HELP FROM GENOMICS 19

REPORT ON FINANCE 21

FINANCIAL STATEMENTS AND ADDITIONAL INFORMATION 22

GRANTS INDEX 30

INFORMATION FOR APPLICANTS 68

PROGRAM APPLICATION DEADLINES 74

ADVISORY COMMITTEES 75

BOARD OF DIRECTORS 81

STAFF 83

CONTACT INFORMATION FOR MAJOR PROGRAMS 86

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Depicted in BWF's logo, the eye of the ancient god Horus is widely considered a symbol of health

ABOUT THE BURROUGHS WELLCOME FUND

The Burroughs Wellcome Fund was founded in 1955 as the corporate foundation of Burroughs Wellcome Co., the U.S. branch of the Wellcome pharmaceutical enterprise, based in the United Kingdom. The Wellcome enterprise was started in 1880 by two young American pharmacists, Henry Wellcome and Silas Burroughs, who had moved to London to manufacture and sell "compressed medicines"—that is, pills—which the pair believed could replace the potions and powders of the day.

Their firm prospered. After Burroughs died in 1895, Wellcome directed the growth of the company into an international network with subsidiaries in numerous countries on several continents. As the business grew, Wellcome held firm to his strong belief that research was fundamental to the development of excellent pharmaceutical products—a belief he put into practice by establishing the industry's first research laboratories.

When Wellcome died in 1936, his will vested all of the corporate shares in a new organization—the Wellcome Trust—devoted to supporting research in medicine and allied sciences and to maintaining museums and libraries dedicated to these fields. Over the decades, the Trust grew to become the world's largest charitable foundation devoted exclusively to the biomedical sciences.

In 1955, leaders at the Wellcome Trust and Burroughs Wellcome Co.-USA envisioned an extension of this effort in the United States—and so was born the Burroughs Wellcome Fund. After nearly four decades as a corporate foundation, BWF in 1993 received from the Trust a $400 million gift that enabled us to become a completely independent foundation, with no direct ties to the founding company. (Nor is BWF affiliated in any way with Glaxo Wellcome Inc., which emerged in 1995 when that firm acquired all of the Wellcome commercial holdings.) With this increase in assets, BWF has been able to play a larger role in funding biomedical research, including extending our support into Canada. In carrying out this work, we are governed by a Board of Directors composed of distinguished scientists and business leaders, and our competitive award programs are directed by advisory committees composed of leading researchers and educators.

The importance of curiosity-driven research, as endorsed by Henry Wellcome, continues as our guide. Thus, more than a century after two enterprising American pharmacists set in motion their pioneering partnership, the Burroughs Wellcome Fund remains committed to the belief that fostering research by the best and brightest scientists offers the fullest promise for improving human health.

REPORT FROM THE PRESIDENT

By Enriqueta C. Bond, Ph.D.

The mission of the Burroughs Wellcome Fund is to advance the medical sciences by supporting research and other scientific and educational activities. Within this broad mandate, we place primary emphasis on basic biomedical science—research aimed at discovering fundamental knowledge that will underpin efforts to improve human health and well-being.

To carry out this mission, BWF's general strategy is to support the development of promising U.S. and Canadian scientists early in their careers and to support investigators working in or entering areas of science that are undervalued or underfunded. Our financial support is channeled primarily through competitive peer-reviewed award programs, which encompass six major categories—career development of scientists, emerging infectious diseases, therapeutic sciences, reproductive science, interfaces in science, and science education. To complement these competitive programs, we also award grants to nonprofit organizations conducting activities to improve the general environment for science.

In this report, I'd like first to survey the current landscape of philanthropic support for health research, and then to describe some of BWF's activities during our previous fiscal year.

Philanthropies and Health Research
For the past several years, BWF has focused part of our effort on learning more about philanthropic contributions for health research. Because we believe so strongly in the value of supporting medical research, BWF has been networking with other like-minded foundations to explore opportunities and gaps in research funding and encouraging others to consider investing in this vital area.

Private philanthropy provides venture capital that is essential to the progress of medical research. Investments could be directed to support institutions, facilities or equipment, specific research projects, or the human capital of the biomedical enterprise—the individual researcher. In playing this catalytic role, private funders may find the most success by focusing their efforts—that is, by identifying opportunities or riskier areas in need of support and then targeting support within those areas.

Private philanthropy provides venture capital that is essential to the progress of medical research.

Although philanthropic foundations are heterogeneous and provide only a small amount of support in comparison to governmental and industrial support, they fill a crucial niche in medical research, and their involvement in this area should be extended. Foundations, in hand with the scientific community, should pursue policies augmenting private contributions, and they should educate potential donors about the nature of medical research, about the value of philanthropic dollars, and about ways to leverage such support.

Total philanthropic giving for 1998 came to $174.52 billion, with $148.46 billion from individuals and bequests, $17.09 billion from noncorporate foundations, and $8.97 billion from corporations. Almost $17 billion, or 9.7 percent, was given for "health." This segment included support of health services and health facilities, such as hospitals and nursing homes; support of organizations addressing general health issues or specific diseases; and a small portion of support for medical research.

Grantmaking foundations contributed $19.46 billion to nonprofit organizations in 1998, representing a 22 percent increase over 1997. This explosive growth was fueled by the prolonged bull market and the near-record levels of gifts and bequests from donors, as well as by the formation of new grantmaking organizations. Since 1980, the number of foundations has doubled to 44,000. Foundations currently spend 16.2 percent of total grant dollars, or $1.2 billion, on health. The largest share of health giving, 58 percent, goes to general and rehabilitative services, including hospitals and medical care; reproductive health; public health; health policy; and management. Of the health portion, only about $265 million, or 22 percent, goes to medical research. In contrast, government support for medical research was roughly $17 billion and industry support was $18 billion.

Philanthropic organizations are a diverse group, including not only corporate and private foundations but also voluntary health organizations and medical research organizations. More recently, conversion health foundations have emerged from the sale of nonprofit hospitals and private insurers. Many of the programs conducted by philanthropic organizations are small, less than $1 million per organization per year, according to a survey of 118 funders conducted by the Pew Charitable Trusts, the Burroughs Wellcome Fund, the American Cancer Society, and the Howard Hughes Medical Institute. Support for postdoctoral researchers and beginning investigators is especially popular. Graduate training in biomedical and health-related research also is supported. Voluntary organizations target educational programs for patients and health professionals. Foundations and medical research organizations emphasize K-12 and undergraduate life science education.

Individual giving amounted to $134.84 billion in 1998. Given that about $13 billion more per year could be obtained if 10 percent of these individuals were encouraged to contribute to medical research, an institutional mechanism might be established to provide a "home" and administrative structure to manage and direct such funds. BWF has supported the Institute for Science Philanthropy as such a tool, and both the National Institutes of Health and the U.S. Centers for Disease Control and Prevention have successfully established foundations that could be conduits for such funds. Many academic medical centers also are likely candidates for individual donations from alumni and grateful patients.

Community foundations, which derive their support from many donors and target their grantmaking within their communities, are likely to benefit most from increased donor support over the next several years, when a large intergenerational transfer of wealth is expected. However, few community foundations give grants for medical research, nor are they viewed as having expertise in this area. BWF has established two health-related research award programs at our local Triangle Community Foundation as models for community-based support. These programs—the George H. Hitchings Fund for Health Research and Science Education, and the Gertrude B. Elion Fund for Health Research—honor pioneering scientists who played influential roles in making BWF what we are today. Dr. Hitchings, who died in 1998, served as BWF's president from 1974 to 1990, and Dr. Elion, who died in 1999, served on our Board of Directors since 1991. In both programs, BWF is partnering with the community foundation to establish new programs to support medical students and early-career faculty investigators, as well as science mentoring.

In fiscal 1999, BWF approved more than $47.3 million in new grants and paid out nearly $26.4 million in grants, both totals greater than in any year in our 44-year history.

Conversion foundations, established as nonprofit health institutions when hospitals or insurers convert to profit-making organizations, offer another potential source of health research support. In 1998, there were 109 conversion foundations in 32 states and the District of Columbia, with total combined assets of more than $13 billion. If these foundations donated 5 percent of their assets every year, as private foundations are required to do by the federal Internal Revenue Service, they would contribute $650 million annually for charitable purposes.

Although surveys indicate that 65 percent of the conversion foundations are dedicated principally to "health and health care," targeted support for medical and health research is actually quite limited. These foundations might direct a larger portion of their grants, perhaps 5 percent to 25 percent, to research yielding better approaches to care for their target populations.

Playing to Our Strengths

The strengths of private funders in supporting health research include the ability to move quickly to fill a gap, to function as neutral conveners for identification of priorities, to model successful approaches, to disseminate approaches that work, and to take risks that may have high payoffs. On the other hand, private funders have limited funds to commit to research; are less willing to support overhead or infrastructure; often desire to model and then move on, rather than to provide long-term sustained support; and have a tendency to carry out their own programs instead of working collaboratively.

In the current health research environment, funders will have to partner and work more collaboratively because of the expense of research. Some of the opportunities for action by foundations include:

- New paradigms for training M.D.s and Ph.D.s to respond to changes in the environment within managed care organizations, industry, and academic health centers.
- Emerging fields and interdisciplinary research (such as genomics and neuroscience), interfaces in science (such as between mathematics and biology or between physics and biology), and biomedical ethics.
- "Risky" or politically unpopular research, such as that in reproductive biology and health, substance abuse, international health and disease, and social/behavioral issues.
- Translational clinical research that speeds results from the research bench to the bedside and to other clinical research areas, including patient-oriented research, epidemiologic and behavioral studies, and outcomes and health services research.
- Behavioral research, which is essential for preventing and treating disease.
- Public understanding of science to help children and adults grasp its importance.
- New partnerships among academic health centers, industry, and managed care organizations through private-sector initiatives related to medical research.

Charitable dollars for medical research, though modest, should be viewed as essential "risk capital" for new ideas and new models. But in order to capture more dollars from private philanthropy, the scientific community must make a stronger case for the relevance of medical research; underscore the critical, catalytic role that even such modest support plays; and support policies that foster charitable contributions. Members of the scientific community should work more closely with advocacy organizations, such as Research!America and Funding First; with their professional societies, such as the American Association for the Advancement of Science (AAAS) and the Federation of American Societies for Experimental Biology; with their universities and academic medical centers; and with their honorary institutions, such as the National Academy of Sciences and the Institute of Medicine, to make a concerted case for greater philanthropic support of medical research.

From this look at what the future could bring, with proper nurturing and cooperation, let's step back to review some of BWF's recent activities.

Overview of BWF Programs

In fiscal 1999, BWF approved more than $47.3 million in new grants and paid out nearly $26.4 million in grants, both totals greater than in any year in our 44-year history. We supported approximately 600 active grants (new and continuing) at more than 200 academic and other nonprofit institutions across the United States and Canada. Some 90 percent of these grants were awarded through our specially designated competitive award programs, with most of the awards earmarked for individual scientists nominated by their institutions. By program area, here are some of the year's highlights:

CAREER DEVELOPMENT OF SCIENTISTS

They are probing the signaling systems in neurons that might go awry in long-term depression, decoding rhythms in the nervous system, and studying the role of muscle proteins in neuromuscular disease. Twenty-four biomedical scientists early in their careers received Career Awards in the Biomedical Sciences. Working across a range of disciplines, these researchers share a common goal: discovery of basic knowledge that ultimately will lead to improvements in human health and well-being. The awards, which totaled approximately $12 million, are intended to foster the development and productivity of these promising researchers and help them make the critical transition to becoming independent investigators. It is expected that by the end of the award period, which ranges from four to six years, recipients will be engaged in productive research programs and will be able to compete effectively for support from government and other extramural sources.

> *Working across a range of disciplines, BWF career award recipients share a common goal: discovery of basic knowledge that will underpin broader efforts to improve human health and well-being.*

BWF initiated this program in 1995, and we now have made a total of 101 awards—an investment of more than $50 million in the careers of biomedical investigators. With the 1999 awards, the program is essentially at steady state, and this increased critical mass brings the opportunity to assess outcomes. Initial data—collected through annual surveys, awardee progress reports, and regular meetings with awardees and members of the program advisory committee—look favorable. For the 1995 and 1996 awardees, 93 percent and 100 percent, respectively, have received tenured faculty appointments—good news, since an important program goal is to help awardees achieve research independence and secure a faculty position.

In another career-development program, BWF awarded Hitchings-Elion Fellowships to five postdoctoral scientists in the biomedical and behavioral sciences. The fellowships, named for the two Nobel Laureates who were long associated with BWF, enable U.S. and Canadian scientists to train for up to three years in laboratories in the United Kingdom or the Republic of Ireland and then return to a North American university to set up their own research programs. Beginning with the 2001 award series, these fellowships will be merged with our Career Awards in the Basic Medical Sciences, to enhance that program's international training component.

BWF also awarded Research Travel Grants to 57 U.S. and Canadian researchers, including six researchers in the history of medicine, to enable them to visit colleagues in the United Kingdom or Ireland for shorter periods (2 weeks to 6 months) in order to participate in collaborative research projects or learn new research techniques. These grants are intended to facilitate the rapid exchange of knowledge and to promote collaboration among scientists in the countries involved.

A guiding principle of BWF's grantmaking is that fostering the careers of our awardees extends well beyond the grant support provided. At the 1999 convocation of career-development awardees, the program was shaped to provide networking opportunities and a chance to explore such critical career development topics as how to negotiate a faculty position, lab management, academic-industry collaboration, dual-career couples, and issues facing women in science. BWF will be issuing a special report on our career development programs by early summer of 2000.

Since postdoctoral students and junior faculty who hope to succeed in science need to uncover the secrets of funding, networking, and the peer-review process, BWF has helped support the launch of a new Career Development Center on the World Wide Web that will address many of these mysteries. The center is part of *Science's* Next Wave, which is administered by the AAAS (and which BWF helped support in its early days). Access is free, and the Web address is http://nextwave.sciencemag.org/feature/careercenter.shtml.

The center, which is cofunded by the Howard Hughes Medical Institute, includes features on such topics as grant writing and grant management, how to set up and maintain a laboratory, how to negotiate for space, and how to assemble a staff. It offers insight into what makes a good proposal and how government agencies make funding decisions, and a "GrantDoctor" column addresses such issues as how to appeal a grant proposal that has been reviewed unfavorably. The site also offers a "reading list" of online reprints and selected resources associated with postdoctoral and junior faculty career development, and it includes a concise bibliography of offline references.

EMERGING INFECTIOUS DISEASES

BWF's award programs target parasitic and fungal pathogens, which despite advances in knowledge of their basic pathology continue to claim millions of lives annually. By supporting a cadre of early- and midcareer investigators, BWF hopes to bring new thinking and research approaches to the areas of molecular parasitology and mycology. We believe that work on these diseases is rich in opportunity for achieving fundamental advances, and that foundations may be able to apply just enough support at certain critical points to shift the balance toward a positive payoff for human health.

> *By supporting a cadre of early- and midcareer investigators, BWF hopes to bring new thinking and research approaches to the areas of molecular parasitology and mycology.*

Two scholar awards and four new investigator awards went to scientists working in molecular parasitology, and two scholar awards and six new investigator awards went to scientists working in molecular pathogenic mycology. The awardees are designing inhibitors to thwart the parasite *Trypanosoma brucei,* which plagues Africa and South America and causes the disease trypanosomiasis, and they are exploring how the body's sensitive endothelial cells respond when infected by *Candida albicans*, a fungus that can prove deadly for individuals whose immune systems have been damaged by disease or other factors, among other projects.

Malaria, which annually claims more than 2 million lives worldwide, is targeted for special support through our New Initiatives in Malaria Research program. This year's awardees are working to discover new drug targets, developing a better understanding of what causes drug resistance, investigating mosquitocidal toxins, and building a database of genetic and biochemical information about malaria.

Beyond BWF's award programs, we teamed with the Wellcome Trust (our sister philanthropy in the United Kingdom) in sponsoring a new trilateral program to support collaborative programs in infectious diseases of major health importance in the developing world. The program is "trilateral" in that it aims to foster existing or new collaborations among researchers in a developing country and researchers in the United States, Canada, or the United Kingdom. The "center of gravity" of these projects will be in the developing world, where bacterial, viral, fungal, and parasitic diseases cause significant morbidity and mortality. Initial plans call for two rounds of awards. During the first round, completed in the fall of 1999, seven awards totaling approximately $18 million went to groups working in a variety of countries, including Peru, Egypt, and Nigeria, and on a variety of maladies, including tuberculosis, hepatitis C, leishmaniasis, and sexually transmitted diseases. Competition for the next round of awards will be announced in early 2000.

Three ad hoc initiatives also deserve special mention. The first is an international effort begun in 1996 to sequence the genome—that is, to identify the order of all the chemical building blocks in the genetic code—of *Plasmodium falciparum*, the most dangerous form of the parasite that causes malaria. *(See the article beginning on page 19 for more information.)* Initially, BWF joined with the Wellcome Trust and, in the United States, with the National Institute of Allergy and Infectious Diseases and the Department of Defense in supporting the Malaria Genome Project. Recently, the World Health Organization, with its current "Roll Back Malaria Program," signed on as a funding partner. The project's researchers have completed the sequencing of two of the parasite's 14 chromosomes, or the thin strands of DNA that form the genetic "roadmap," and sequencing of the remaining chromosomes is progressing well. The information being generated already is proving useful to the biological community in its search for new targets for drug and vaccine development, as well as for better understanding of the pathogenesis of this dreaded disease.

A second BWF effort is jump-starting research efforts to sequence the genomes of several pathogenic fungi. This has provided an opportunity for BWF to translate the lessons we have learned in the Malaria Genome Project—namely, the importance of providing support to help mobilize the community, of supporting interaction and collaboration through meetings, and of developing a plan to fund and pursue the genome projects. *(See page 19 for more details.)*

Finally, recognizing the need to provide state-of-the-art training in the molecular study of fungal and parasitic pathogens, BWF continued our support of two training courses for advanced graduate students, postdoctoral fellows, and independent investigators, held at the Marine Biological Laboratory in Woods Hole, Massachusetts. In addition to introducing participants to medically important pathogens, as well as to the latest methods for molecular manipulation and analysis, these courses provide an important means to improve networking within the research community and to attract scientists into these underfunded areas of research.

THERAPEUTIC SCIENCES

BWF's programs span the spectrum from basic studies in pharmacology and toxicology to patient-oriented research. These programs share a common theme: seeking to advance our knowledge of human health by acquiring more information on the effects of drugs, toxins, and disease processes at the molecular, cellular, and organ levels, as well as at the level of the entire organism, including humans.

Ten new investigators at the beginning stages of their faculty careers received awards in the pharmacological and toxicological sciences. BWF believes that fostering the career development of tomorrow's leading scientists offers an effective way to strengthen and expand interactions between the pharmacology and toxicology communities. These fields share much in common: both are inherently multidisciplinary, and both are well-positioned to capitalize on the new ideas and experimental approaches emerging from such frontiers of investigation as the computational sciences, animal models, and molecular genetics. We encourage the broadest definition of these disciplines, not so much in terms of how they are traditionally recognized, but by how the latest research advances might be brought to bear upon them. For example, the awardees are taking a genetic approach to uncovering the mechanisms of how neurons communicate, and examining gene regulation in the formation of tumors, among other projects.

> *Fostering the career development of tomorrow's leading scientists offers an effective way to strengthen and expand interactions between the pharmacology and toxicology communities.*

BWF named nine recipients of Clinical Scientist Awards in Translational Research, for a total investment of $6.75 million. *(See the article beginning on page 11 for more information.)* This program seeks to help correct the current deficiency in physician investigators and to build a cadre of clinical scientists who can translate advances in the basic biomedical sciences into greater understanding of the natural history of disease, improved clinical knowledge, and better diagnosis and treatment. The awards support midcareer clinician-scientists, and they are intended not only to "protect" awardees' time for research, but also to provide them with time to serve as mentors for the next generation of physician-scientists.

BWF's awards in translational research will enable recipients to explore important scientific questions, to apply the resulting knowledge at the bedside, and to bring insights from the clinical setting back to the laboratory for further exploration. For example, awardees are testing new strategies for preventing and treating diabetic complications, exploring the mechanisms that lead to heart disease and colon cancer, and studying new avenues for fighting the AIDS virus. These efforts, it is hoped, will lead to a better understanding of the mechanisms of disease, as well as to new methods of diagnosing, treating, and preventing disease.

In other activities, BWF connected to professional and scientific organizations in pharmacology, toxicology, and medical research by sponsoring plenary lectures at the annual meetings of the Society of Toxicology, the American Society for Pharmacology and Experimental Therapeutics, the American Federation for Medical Research, and the newly launched Association for Patient-Oriented Research. We also participated in the annual meeting of the directors of M.D.-Ph.D. training programs at academic medical centers to discuss our interest in attracting more students into clinical research.

In addition, we provided support to launch what may become an important mechanism for collecting data and examining issues important to the success of the clinical research enterprise. This idea grew out of the recommendations made at the National Clinical Research Summit—convened during 1998 and 1999 by the American Association of Medical Colleges and the American Medical Association, and supported by BWF. BWF made a three-year, $150,000 grant to the Institute of Medicine to help establish the Clinical Research Roundtable, which will provide a forum and sponsor workshops for discussion of approaches to both acute and long-term issues affecting clinical research. Among other activities, the roundtable will work to enhance mutual understanding of clinical research within the scientific community and the general public, while enhancing the public's participation in clinical studies.

REPRODUCTIVE SCIENCE

Fundamental gaps remain in our knowledge of such basic areas of reproductive science as the immunology of pregnancy, causes of premature birth, and endocrine regulation. Although this area receives the smallest annual BWF investment, it is one that we continue to explore in order to find ways to build much-needed research capacity. BWF has convened two focus groups of scientists to help us better understand the state of the field, scientific opportunities, and how to train and support researchers working in reproductive science.

BWF currently supports the field of reproductive science through three avenues: the allocation each year of at least one of our Career Awards in the Biomedical Sciences; an annual postdoctoral research fellowship administered by the American Association of Obstetricians and Gynecologists Foundation; and an annual award for one faculty-level award recipient in the Reproductive Scientist Development Program, which is administered by a consortium of government and private organizations. In addition, we have continued our support of the Frontiers in Reproduction training course, now in its second year and held each summer at the Marine Biological Laboratory. This is a hands-on, laboratory-based course that is led by a faculty of leading basic and clinical scientists. Drawing an international group of participants, the course provides comprehensive and sophisticated training in research strategies and state-of-the-art laboratory methods bearing on cellular, immunological, and molecular biological approaches to important problems in reproductive science.

INTERFACES IN SCIENCE

Some of the most promising discoveries in biomedicine have resulted from the insights of investigators with strong backgrounds in physics, chemistry, and mathematics. Examples of interdisciplinary research include the use of x-ray diffraction to analyze the interactions between drugs and enzymes, the use of functional magnetic resonance imaging to see where information is processed in the brain, and the use of mathematical models to analyze human genome sequences for biologically meaningful information. Fostering such fertile "connectedness" is the goal of BWF's Interfaces between the Physical, Chemical, Computational Sciences and the Biological Sciences program.

Some of the most promising discoveries in biomedicine have resulted from the insights of investigators with strong backgrounds in physics, chemistry, and mathematics.

Begun in 1996, this program provides institutional support for graduate and postdoctoral training. The goals are to facilitate disciplinary transitions at academic institutions and to train investigators coming from quantitative and theoretical backgrounds so they can introduce new approaches and new ideas into the biological arena. In 1999, BWF made two awards—totaling $4.8 million—to support programs at Brown University and Johns Hopkins University.

Brown's Brain Science Interfaces Program, say its directors, "will capitalize on a culture of interdisciplinary interaction and a strong, collegial faculty" to train students from the physical and computational sciences in the emerging field of brain science. "Scientists with quantitative and theoretical skills are needed to guide the development of fundamental principles of brain function using the mass of data provided from the past decades of neuroscience research," they add. "This interdisciplinary effort incorporating theoretical, analytical, and computational approaches will create a better understanding of large-scale phenomena that emerge from nerve cells."

At Hopkins, the Program in Computational Biology will train both Ph.D. and M.D.-Ph.D. students and postdoctoral fellows in computational biology, with a particular emphasis on computational genomics. This approach, say its directors, will feature the integrated application of both experimental and theoretical methods—an approach more typically employed in the physical sciences—to complex problems in biology and molecular biology. Of particular note, the students will complete a three-month internship at the Institute for Genomic Research, a not-for-profit organization devoted to analyzing genomes and gene products in a variety of organisms, including humans. This internship represents a dynamic opportunity for students to learn techniques that are important to industry. Such experience may well prove vital, as more students in the life sciences either will take jobs in industry or, as university researchers, will work closely with industrial scientists on projects to advance human health.

In the spirit of bringing scientists together, BWF has provided a grant to enable one of our first program awardees, the La Jolla Interfaces in Science Program, to hold a meeting on the scientific and career challenges of "working at the interface." The meeting, held in January 2000, brought together BWF-supported students participating in the interdisciplinary training programs. In addition to serving as a scientific forum, the meeting encouraged the students to develop peer networks and gave them the opportunity to interact with established investigators. The results of this meeting will be shared in next year's report.

In 1999, BWF introduced a $3 million program, Innovation Awards in Functional Genomics, to draw new and exciting ideas into this emerging field. Genomic sequencing and structural mapping projects for many organisms, including humans, are well under way. The next and greater scientific challenge will be to define not only the functions of genes but also how they interact within the context of the whole organism. The new program's goal is to integrate the vast amount of genetic sequence and expression data being generated in the world's laboratories into functional and clinically relevant information that will yield insights into mechanisms of human disease. Awards will be made in two areas: animal model development and computational methods development. The "innovation" aspect means BWF is seeking truly novel hypotheses and approaches that may lack pilot data. Despite their inherent risk-taking nature, however, projects must nonetheless demonstrate solid scientific judgment and the potential for high impact.

SCIENCE EDUCATION

The cornerstone of a strong research enterprise rests on educational programs to interest students in science and help them gain the knowledge and skills necessary to pursue a scientific career. Toward this goal, BWF made 10 Student Science Enrichment Program (SSEP) awards that are enabling middle school and high school students across North Carolina to learn firsthand about science and the excitement of research. Digging into a variety of activities, the students are working alongside leading health scientists, exploring aquatic environments, and assisting in museums.

> *The cornerstone of a strong research enterprise rests on educational programs to interest students in science and help them gain the knowledge and skills necessary to pursue a scientific career.*

The projects give students the opportunity to participate in hands-on, inquiry-based avenues of exploration—an educational approach that BWF believes to be an effective way to increase students' understanding of science. Museums, schools, community organizations, and universities have formed a variety of partnerships to provide students access to resources not readily available to most secondary school students.

The 1999 awards bring to almost $5 million the total that BWF has invested in science-enrichment programs during the past four years. A total of 38 organizations have received SSEP awards, and the programs have reached more than 20,000 middle school and high school students. Through these programs, BWF seeks to encourage the widespread use of creative inquiry-based science education and to foster the development of effective materials and methods for teaching science. BWF's resources are not sufficient to change the nation. But we feel that these enrichment projects can produce measurable results on a smaller scale—awards are limited to our home state of North Carolina—that will directly and immediately affect real students in real schools. Our broader goal is to see the lessons learned from these projects incorporated into nationwide efforts to improve science and mathematics education—at all levels, in all schools, and beyond classroom doors.

In recognition of the importance of linking these programs to one another and of broadening their reach to include parents, teachers, and other students, BWF has expanded a special SSEP website (http://ssep.bwfund.org). Administered by the Shodor Education Foundation, which conducts one of our SSEP programs, this site provides information on experiential science programs for students, offers a variety of activities, and enables students and SSEP project directors to communicate with one another. The 1999 annual convocation of SSEP directors encouraged the sharing of information focused on three topics: student recruitment, program sustainability, and evaluation efforts.

In another activity focused on improving education in North Carolina, BWF helped sponsor a visit by a group of 29 state policymakers, business leaders, and educators to England to study the issues of school choice and school accountability. In 1997, the Public School Forum of North Carolina, with support from BWF, formed the Institute for Educational Policymakers. The institute's mission is to help members of the state legislature, the state board of education, and the news media learn about the complex issues surrounding school improvement, including the areas of science, mathematics, and technology. In North Carolina, as in many other states, school choice is an issue that recently has moved to the proverbial front burner. Thus, the institute deemed England a natural "laboratory" ripe for exploration, since that country has embraced the concept of school choice for decades and its experience may hold lessons for others.

BWF also supports science-education award programs that reach far beyond North Carolina. In 1999, our visiting professorship programs in the basic medical sciences and in the microbiological sciences enabled more than 40 colleges and universities in the United States and Canada to bring in distinguished scientists from around the world to teach and interact with faculty and students. The institutions report that these visits yield lasting benefits, as participants have an opportunity to learn firsthand from leading experts in a range of biomedical disciplines. The professorships prove especially valuable for institutions with predominantly minority enrollments, as well as for smaller institutions, newer institutions, and those located in less urban areas.

ENVIRONMENT FOR SCIENCE

To complement our competitive award programs, BWF allocates approximately 10 percent of our annual grants to support activities that strengthen the well-being of the research enterprise, in general, and of the fields that we have targeted, in particular. This effort includes support for such activities as meetings, workshops, and training activities. For example, BWF partnered with the Lasker Foundation and the American Association for the Advancement of Science in sponsoring a meeting of policymakers to explore ways of financing medical research. The resulting publication, *How to Fund Medical Research*, is available online on the AAAS website (www.aaas.org/spp/dspp/cstc/fundscience.htm).

In another project, BWF provided support to the National Health Policy Forum for an initiative relating to the role and value of medical research. Based at George Washington University, in Washington, D.C., the forum is a nonpartisan educational organization that promotes informed health-policy decision making in the federal government. The initiative features a series of meetings and site visits, along with the preparation of briefing papers and case studies, to help illustrate for policymakers and others the public stake in biomedical research. A vast array of organizations, including academic health centers, will play a significant role in determining what shape biomedical research will take in the next decade.

> *The goals of BWF's "terrain mapping" are several: to gain a sense of where biomedical science is moving and what the needs for human capital will be, and to determine whether there are program opportunities for us to explore in this future landscape.*

Closely aligned with BWF's scientific programs are our communications efforts. These efforts are aimed primarily at attracting qualified applicants to our programs, providing visibility to the efforts and research accomplishments of our award recipients, and drawing increased attention to our targeted, underfunded areas in hope of generating increased support from other public and private sources. Recognizing, too, the need to facilitate and improve the reporting of science to the broader community, BWF has continued our support of the AAAS's science media fellowships, as well as our support of the Council for the Advancement of Science Writing's annual New Horizons in Science Briefing, which attracts journalists from across the nation to hear about the latest from the laboratory and the clinic.

Looking Ahead

Throughout the year 2000, BWF's board and staff will be reviewing our major focus areas, which were established in 1995 with an eye to regular reevaluation. The goals of this "terrain mapping" are several: to gain a sense of where biomedical science is moving and what the needs for human capital will be, and to determine whether there are program opportunities for BWF to explore in this future landscape.

The challenge is that BWF now is at steady state in grantmaking, so we cannot add new dimensions without making changes in current programs. This means we must consider priorities, adopt a strategic focus, and be guided in our approaches by the unique role of private foundations in providing venture capital and supporting new research talent. And we must strive to set our agenda in a way that complements, rather than duplicates, what other organizations, including the federal government, are doing. A big job indeed. But we feel that if past success is a guide, the Burroughs Wellcome Fund will move into the new century well positioned to help advance the medical sciences and improve human health.

Enriqueta C. Bond

GENERATING NEW MEDICAL KNOWLEDGE: CLINICAL SCIENTIST AWARDS IN TRANSLATIONAL RESEARCH

"I am a true clinical investigator, not a laboratory investigator visiting the clinic," proclaims Eva Guinan, M.D., a 1999 recipient of a Burroughs Wellcome Fund Clinical Scientist Award in Translational Research. "I have a strong lab background, and I also work with patients—so I'm always trying to be in two or three places at once." At any given moment, these places might include a clinic, an office, and a laboratory, since Dr. Guinan is an associate professor in pediatrics at Harvard Medical School and director of the Bone Marrow Transplant Program at Children's Hospital/Dana-Farber Cancer Institute, with clinical appointments also at Brigham and Women's Hospital. Running a large practice, writing and managing numerous clinical protocols, serving on medical review boards, teaching and supervising the work of junior staff—all these worthy tasks compete in her workday for a precious resource: time. Caught short in the competition has been the research that Dr. Guinan feels is really her primary calling. "Most important for me, intellectually and emotionally, is creating new treatment opportunities for patients," she says.

Matters came to a head seven years ago when Dr. Guinan, 20 weeks pregnant, went into early labor and was ordered to undergo strict bed rest for the remainder of the pregnancy. Fearful of losing her child, she complied—and found herself in a unique professional environment. Because she was temporarily unable to carry out her clinical responsibilities, Dr. Guinan actually had time to reflect and to write. Her thoughts turned toward a line of investigation that she had long been developing with Lee Nadler, M.D., chair of Adult Oncology at Dana-Farber. "I wrote the grant proposal with a laptop computer balanced on my pregnant belly," she laughs. The grant, for the study and testing of a new approach to reducing the risk of graft-versus-host disease in bone marrow transplantation, was funded by the National Institute of Allergy and Infectious Diseases, and Dr. Guinan has been forging ahead in this area ever since.

A major paper published by Dr. Guinan and her colleagues in the June 3, 1999, issue of the *New England Journal of Medicine* describes the new approach, which aims to produce a kind of specific immune suppression known as "anergy." For the patient who is receiving a bone marrow transplant, an immune reaction by the graft against the recipient is a very serious problem—sometimes even fatal. Until recently, the only way to reduce this risk has been to suppress all immune function in the donated bone marrow, using techniques that carry major risks of their own. In a condition of anergy, however, the T cells of the donated bone marrow retain almost all normal immune function—except that they do not become activated to attack the cells of the recipient. This unique condition is produced as the result of a technique pioneered by Drs. Guinan and Nadler: culturing irradiated cells from the recipient together with a protein, called CTLA-4-Ig, that blocks a crucial step, called costimulation, in the T cells' immune signaling pathway.

Dr. Guinan's paper documents the effectiveness of the anergy approach in 11 bone marrow transplant recipients, but other types of patients stand to benefit as well; for instance, clinical trials in kidney transplantation are scheduled to begin within the year. If the technique proves to be broadly applicable, it may change fundamentally the field of organ donation and transplantation. Fewer transplant failures will mean that more organs are available for those who desperately need them; moreover, the histocompatibility "matching" of donors and recipients may no longer need to be so precise, once the signaling pathway for an immune-system attack has been disrupted.

BWF's translational research award, says Dr. Guinan, has opened up rich new opportunities for her to pursue this most promising line of investigation: greater visibility for her work, more laboratory space, the prospect of more postdoctoral fellows to work with her, and the interest of potential collaborators who are eminent researchers in their own right. But the circumstances that allowed her to write the original grant proposal seven years ago still leave her with deep concerns about the scant support available to clinical researchers like herself. Before receiving BWF's award, she says, "Enforced bed rest was the only protected time I've had in my professional career—and that's absurd."

Troubled Waters

BWF has made Clinical Scientist Awards in Translational Research to 18 other U.S. and Canadian researchers since the program's inception in 1998. *(See the accompanying vignettes for descriptions of the work being conducted by a number of these awardees.)* Linking "bench and bedside," the concept of joining research and patient care, is time-honored in medicine, dating back to the first physicians, who had to be sharp observers and often keen investigators as well.

Physician-scientists have added immeasurably to human health by their achievements, from Edward Jenner's vaccination against smallpox, to Alexander Fleming's discovery of penicillin, to John Cade's breakthrough treatment of bipolar disorder with the simple salt lithium. In recent years, however, clinical research has entered troubled waters, as the overall climate for academic research continues to evolve under the pressure of tightening resources. Once deliberate in pace and scholarly in manner, medical research today must be concerned equally with results and with the public understanding of those results.

Several sectors of the research enterprise have responded vigorously and even thrived in response to these new pressures. The prospect of hastening clinical applications draws well-deserved support from the private as well as the public sector; meanwhile, basic scientific investigation remains on a solid footing by virtue of hard work in both the laboratory and the public arena.

Fingerprinting Gene Expression

Gilbert Chu, M.D., Ph.D., is screening for genes that determine why different individuals have widely varying responses to the same cancer treatment. "I'm interested in new opportunities to analyze human genes with unprecedented rapidity in ways that can be applied to important medical problems," says Dr. Chu, an associate professor of medicine and biochemistry at Stanford University.

Dr. Chu's unique perspective may derive in part from his having trained as a researcher first and a clinician second. Beginning his career as a theoretical physicist, he studied fundamental particles that are the building blocks of matter before entering medical school to work with patients. Later, as a postdoctoral fellow, he drew on his background in physics to invent a device for separating very large DNA molecules, the fundamental units of the genetic code. Now, as a faculty investigator who also cares for cancer patients, he focuses his research on understanding how cells recognize and respond to DNA damage, such as that produced by ultraviolet or ionizing radiation.

Gilbert Chu "is always considering how to apply new basic science discoveries to the clinical practice of medicine," says Dr. Ronald Davis, director of the Stanford DNA Sequencing and Technology Center. The project for which Dr. Chu has received BWF support is an example of just this sort of undertaking: using the latest technology to screen large quantities of DNA very rapidly, with the goal of pinpointing the genes that make some individuals particularly sensitive to radiation therapy.

One technique, called denaturing HPLC, allows the investigator to scan 2,000 bases of DNA in seven minutes, as compared with the conventional method of running gels, which yields a scan of 300 bases in an hour. In another approach, a "gene chip"—a high-density array of oligonucleotides immobilized on a one-centimeter chip—can probe the response to ionizing radiation of some 6,500 genes at once, as compared with the conventional test that examines one gene at a time.

"The overarching idea," says Dr. Chu, "is that every cancer patient presents a unique problem, because each instance of cancer is unique and each patient's response to treatment also is unique." He hypothesizes that patients who suffer particularly strong side effects from radiation treatment may in fact be carrying genetic mutations that dictate this abnormal response. Dr. Chu predicts that today's new high-speed screening techniques will eventually locate all the genes involved in the body's response to radiation and many other cancer treatments. "The long-range goal," he says, "is to develop a method for deciding how each cancer patient should be treated." A number of options are now available for the treatment of almost any kind of cancer; but the best option for one patient may be ineffective or even harmful for another. If Dr. Chu's method of gene-expression "fingerprinting" is successful, then physicians will at last be able to take the individual patient's sensitivities and likely responses into account as they weigh the options and proceed with the best possible treatment.

But between these two strong areas, the field of translational research—which BWF views as the two-way transfer between basic research and patient care—has been losing ground for some time. While enrollment in medical schools has increased throughout the past three decades, fewer newly graduated doctors have chosen to enter research fields; the majority look forward to a professional future spent entirely in clinical work. As just one measure of this trend, the number of M.D.s submitting first-time applications to the National Institutes of Health (NIH) for research grants dropped more than 30 percent in three years, from 1994 to 1997, according to Dr. Leon Rosenberg, writing in the January 15, 1999, issue of the journal *Science*. Medical science and patient care seem to have come to a parting of the ways.

As far back as 1979, the president of the Association of American Physicians, Dr. James B. Wyngaarden, issued an alarm about a decline in the ranks of clinical investigators, calling it a "danger to the survival of the species in the numbers and quality needed to maximize the rate of progress against the serious diseases of mankind." This decline was subtle at first but became unmistakable over the course of the next two decades: for instance, the joint annual meeting of the American Society for Clinical Investigation, the Association for American Physicians, and the American Federation for Medical Research, which had enjoyed a steady attendance of about 3,600 members from 1978 to 1990, suddenly shrank to less than half its former size, convening fewer than 1,700 members in 1996. Over the same period, attendance at the annual meeting of the American Society for Human Genetics rose rapidly, from under 2,000 to almost 5,000. Today, noted Dr. John I. Bell of the University of Oxford in the May 1999 issue of *Nature Medicine*, "The old-style clinical scientist, capable of studying systems physiology and pathophysiology in patients, is now all but extinct and has given way to the linkage mappers, gene cloners, and structural and developmental biologists."

Practical factors have played a part in the decline of translational research. For the new graduate whose medical degree is accompanied by a debt of tens of thousands of dollars, the prospect of immediate, steady, and well-compensated employment as a physician may quite understandably appear to be a more responsible choice than the uncertain and highly competitive process of applying for research funding. Many talented physicians try to keep a foot in both worlds, but those who join academic centers hoping to divide their time between clinical work and research often find that the responsibilities of patient care, supervision, and teaching can all too easily fill what might otherwise be productive research time. Recent findings from more than 460 academic departments of neurology throughout the United States illustrate the severity of these time constraints. Only 18 percent of clinicians had more than half of their time protected for research, whereas 74 percent of basic scientists had at least half their time protected in this way, according to a survey conducted by the American Academy of Neurology and published in the April 1995 issue of *Neurology*.

Patient care and research projects may be in competition at the level of whole institutions, as well. A study by Dr. Ernest Moy and others in the July 16, 1997, issue of the *Journal of the American Medical Association* found an inverse relationship between growth in NIH awards to 115 U.S. medical schools and the penetration of managed care into the health-care market where these schools were located. The authors were not able to determine whether this was a causal relationship or simply an inverse correlation over the course of a decade, but certainly their findings provide food for thought. To make matters worse, as managed-care enrollments have grown and insurance coverage has assumed greater weight in decisions about patient care, fewer patients have become available for studies of new,

Fighting Free Radicals

Atherosclerosis, many neurodegenerative diseases, and the paralyzing aftereffects that sometimes follow a stroke are all linked to a powerful biological process known as oxidant stress. "Oxidant stress, or oxidative injury, is a term that refers to the presence in the body of too many free radicals—that is, a kind of molecule that is derived from oxygen and is very unstable," says Jason Morrow, M.D. Free radicals have the potential to damage important biomolecules, including proteins, lipids, and DNA, by modifying them chemically, destroying their ability to function.

"The human body has developed an inordinate number of mechanisms to repair or control oxidative stress," continues Dr. Morrow, who specializes in this field as a professor of medicine and pharmacology at Vanderbilt University Medical Center. His research focuses on a family of molecules called the isoprostanes, which form spontaneously in the body in response to oxidative stress. "The chemical reaction of oxygen with arachidonic acid [a major component of all cell membranes] gives rise to a number of prostaglandin-like molecules, one of which is the isoprostanes," Dr. Morrow explains. He has been able to determine that isoprostane formation occurs very predictably and consistently in this way—so much so that spectrometric measurements of isoprostane formation have become the "gold standard" for assessing oxidative injury in vivo. Previous methods had performed well in the test tube but fallen short in their application to living humans. "There had been a translational gap there, no doubt about it," says Dr. Morrow, who has received three patents for this new means of assessing oxidative injury.

But his investigations don't end there. Dr. Morrow is now looking more closely at the process of isoprostane formation, as well as at the metabolism and biological activity of these compounds once formed. He also uses mass spectrometry to study certain compounds that inhibit isoprostane formation—notably, vitamins E and C—to try to see how they achieve this protective effect.

Another of his endeavors is fostering an interest in clinical research among new medical students. In this regard, Vanderbilt University, with its strong tradition as a research-oriented medical school, has proved an ideal setting. Several years ago, Dr. Morrow was asked to launch the Medical Scholars Program, in which five medical students are given the opportunity (with stipend) to add one year of intensive research to their curriculum. "Some two hundred faculty members are available as mentors through this program, so the choices for research area range from molecular to clinical to epidemiological," he says. On completion of the research year, each scholar gives a formal presentation, and publications are encouraged as well. "Last year, with five scholars, we had eight publications. That's a lot," Dr. Morrow says proudly. But his plans for the future are bigger still: Vanderbilt has applied to the National Institutes of Health to fund three additional medical scholar positions—and these three will be designated specifically for translational research.

unproven treatments, and proposals for such studies are subject to time-consuming review by more parties than ever before.

Turn of the Tide

“Time to get serious about clinical research,” the *Journal of NIH Research* proclaimed in its September 1997 issue. At that time, the NIH was welcoming the first participants in its new Clinical Research Training Program, which would provide a year of intensive, mentored research for nine third-year medical students. This program was one result of a Clinical Research Panel that had been convened by Dr. Harold Varmus, director of the NIH, in 1995. The panel also advocated for a requirement that all institutions receiving NIH support provide formal training and mentoring experiences for clinical scientists, and recommended instituting a loan repayment program for clinical investigators as well as establishing new grants for clinical research, both at the entry level and the midcareer stage. The General Clinical Research Centers came in for their share of attention, as the panel recognized their leading role in clinical research and urged the NIH to increase their funding significantly. A final recommendation from the panel was for greater NIH efforts “to educate the public about the crucial importance of clinical research for the future health of the nation.”

Understanding Asthma

Christian Schindler, M.D., Ph.D., works with mice that suffer from a severe allergic type of asthma, which constricts their airways and sends their bronchial muscles into spasm. These mice are a well-established model for human asthma, and Dr. Schindler's research is aimed at a better understanding of the molecular signals and events that trigger this life-threatening response in so many people—more than 14 million in the United States alone.

“In asthmatic constriction of the airways it was once thought that the mast cell, a type of myeloid cell, was the key player,” he says, “but more recent studies point to eosinophils, which are important in all types of allergic reactions.” In the airways, eosinophils (which also belong to the myeloid family) secrete several different molecules that induce a state of hyperreactivity. These eosinophils are “recruited” to the airways from the bone marrow, via the circulatory system. This response is stimulated by a cytokine known as IL-5. It is the signaling pathway used by IL-5 that has attracted Dr. Schindler's interest. “All cytokines bind to receptors, which then signal responses by turning on new genes in the target cell,” he explains. “IL-5 uses the transcription factor Stat5 [for signal transducers and activators of transcription]. In immature myeloid cells, there is a protease that cleaves the Stat5 transcription factor, and it appears this step is important for myeloid development.”

Dr. Schindler, an assistant professor of microbiology and medicine at Columbia University College of Physicians and Surgeons, has zeroed in on this step. “We have identified the cleavage site on Stat5 and eliminated it, so the transcription factor is now cleavage-resistant,” he says. “Our hypothesis is that eosinophil development will be impaired, so that the eosinophils will not be available to produce an exaggerated allergic reaction—and these animals won't develop asthma.”

In its elucidation of asthma at the molecular but not the genetic level, Dr. Schindler's work offers an interesting example of the flexible approach that characterizes translational research. As he explains, “Rather than going to the origin of asthma and trying to reverse that, this works a step or two ‘downstream,’ crippling the allergic reaction.” By learning more about the complex chain of signals required to produce the allergic response of asthma, Dr. Schindler found himself able to identify a promising new prospect for treating this disorder. “The protease that cleaves Stat5 is an appealing drug target,” he says, because if the protease can be prevented from cleaving Stat5 in the normal way and IL-5 therefore cannot use Stat5 as a transcription factor, then the eosinophils will not be recruited to the airways to induce the hypersensitivity of asthma.

Dr. Schindler's mouse model has served him well so far, and he hopes it may help him discover other potential targets for intervention along the IL-5 signaling pathway of asthma.

Interestingly, one of the first challenges facing the NIH panel was to agree on a common definition of the very field under discussion. Given the tremendous variety of questions addressed under the heading of clinical research, and the strongly interdisciplinary nature of the enterprise, this was no simple task. “A translational, iterative process involving bedside observation backed up by molecular insights and technologies” is the careful formula offered by Oxford's Dr. Bell; but others have been less precise, if no less definite. “It's not easy to define, but you know it when you see it” has been the informal consensus of those in the field. The NIH panel ultimately settled on a working definition of clinical research that included epidemiologic and behavioral studies, outcomes and health-services research, and patient-oriented research. As for the latter, Drs. Joseph Goldstein and Michael Brown, writing in the June 1997 issue of the *Journal of Clinical Investigation*, jocularly observe, “As a rule of thumb, if the investigator shakes hands with the patient in the course of the research, that scientist is performing patient-oriented research.”

Congress, too, has taken up the question of clinical research, not to define it but to attempt to see what ails it and how it might be strengthened. In 1996, Senators Mark Hatfield and

Ted Kennedy had sponsored the Clinical Research Enhancement Act, which would allocate more NIH funding for clinical scientists and for extramural clinical centers. The bill also would appoint leaders from governmental and academic research centers, private funding institutions, and the health-care industry to study the state of clinical research and to make recommendations for action.

There are encouraging signs that the tide of translational and patient-oriented research, having reached its lowest point, may at last be turning. In the federal arena, the NIH in 1998 launched a new series of career-development awards and training grants for clinical investigators. Outside of government, a number of professional societies provide a forum in which clinical scientists can offer one another professional support. These societies include the Association for American Physicians; the American Society for Clinical Investigation; the American Federation for Medical Research; and the Association for Patient-Oriented Research, an international society started in 1998. In addition, funding organizations both large and small are providing another kind of support, in the form of grants to institutions and individuals. These grants range in scope from the major investment by the Howard Hughes Medical Institute in a four-year Biomedical Research Support Program for medical schools to the one-year ASCO-Janssen Young Investigator Award for mentored, ras-related translational research. In other examples, the Charles A. Dana Foundation sponsors a three-year Clinical Hypotheses in Neuroscience Program, the American Cancer Society offers mentored Clinical Research Training Grants of one to three years for junior faculty, and the Donald W. Reynolds Foundation offers support for 16 clinical researchers in its Cardiovascular

Why Hearts Fail

Howard Rockman, M.D., an associate professor of medicine at Duke University Medical Center, is a cardiologist who became fascinated by heart failure. "At work in the heart is an amazingly complex regulatory system that, when things start to go wrong, really falls apart," he says. His research focuses on how beta-adrenergic receptors in the heart sometimes become "desensitized"—that is, they fail to respond normally to adrenaline—with disastrous results, and what can be done to treat such cases.

"Most of the time," Dr. Rockman says, "congestive heart failure is caused by an antecedent heart attack. This is like someone who starts with five fingers on a hand, loses two of them, and then finds over time that the remaining three are starting to weaken. For me the question is, why does the normal undamaged tissue in the heart begin to fail after having survived the trauma of a heart attack?"

The answer, it appears, has to do with a molecule called beta-adrenergic receptor kinase, or ßARK. In healthy heart muscle, the beta-adrenergic receptors receive signals from the brain and the adrenal glands when the animal perceives a threat; this is the "fight or flight syndrome," causing the heart to beat faster in readiness for quick action. The ßARK molecule has the equally important role of turning off the beta-adrenergic receptor, thereby blunting the stress response, when the crisis is resolved.

If the heart has lost some portion of its muscle in a heart attack, however, it may no longer beat as effectively as before. The body, sensing this, tries to increase heart rate by releasing more adrenaline and other "fight-or-flight" hormones into the blood; the heart then responds to this overstimulation by becoming less sensitive. "This becomes a vicious cycle," says Dr. Rockman. "The body says there's not enough output from the heart and therefore turns up the signal volume; the heart protects itself by lowering the number of receptors and thereby becoming less sensitive; and lower sensitivity to signals brings about a lower heart output."

Figuring out a way to break the cycle involved a combination of several transgenic mouse models. Dr. Rockman and his colleagues developed a mouse that over-expressed ßARK by three to four times, and another that over-expressed an inhibitor of ßARK, but only in heart muscle. In the first mouse, the heart did not fail, but neither did it respond normally to adrenaline. In the second mouse, with ßARK inhibited, the heart had an enhanced response to adrenaline. He then mated these animals with another strain of mice that had been bred to develop heart failure much like the human form of the disorder. At maturity, the mouse without the ßARK inhibitor showed advanced heart failure—the heart was overly large and almost unable to contract at all—whereas in the mouse with a ßARK inhibitor, the heart was normal. "You can't get it any better, because we're comparing apples to apples," proclaims Dr. Rockman. "The only difference between these two models is whether the hearts contain the ßARK inhibitor."

The crucial next step in this work is to produce a mouse model in which the ßARK inhibitor can be turned on or off by some easily accessible means. Dr. Rockman settled on using tetracycline, a commonly available antibiotic, as a stimulus to turn on a gene that in turn acts to inhibit ßARK. "This tetracycline transgenic mouse was what we received the BWF award for," he says. "Now we need to show that long-term administration of ßARK inhibitor, say over the course of a year, can actually reverse heart failure." The signs so far are good, according to Dr. Rockman—and to prospective partners. Several pharmaceutical companies have expressed interest in developing a ßARK inhibitor, and Dr. Rockman is hopeful that in several years such a drug will be available to test in multiple animal models of heart failure as it comes closer to the goal of saving human lives.

Research Center. The Damon Runyon-Walter Winchell Foundation has enhanced its commitment to cancer research with a new long-term program in career development that includes debt forgiveness for medical students entering the area of translational research; and the Doris Duke Charitable Foundation, itself established only in 1998, offers a Clinical Scientist Award for New Investigators in four specific areas: heart disease, AIDS, cancer, and sickle-cell anemia and other blood disorders.

Promising Gene Therapy

Fanconi anemia is the specific disease through which Hagop Youssoufian, M.D., explores new ideas for gene therapy for a variety of blood-cell disorders. Although rare in the general population—Fanconi anemia causes disease in only about one of 350,000 Americans—in specific populations it represents a significant health risk. Among Ashkenazi Jews in the New York area, for example, one in every 100 individuals carries a defective gene for a particular subtype of the anemia. Unfortunately, patients with Fanconi anemia also are at increased risk of developing virulent leukemia, often by early adulthood. Bone marrow transplantation is an effective treatment but comes at great expense and carries grave risks of its own, as well as being severely limited by the pool of available donors. Dr. Youssoufian, an associate professor of molecular and human genetics and of medicine at Baylor College of Medicine, is working to develop a protein-based treatment instead.

His work holds great clinical implications, because Dr. Youssoufian has chosen to tackle one of the flaws that is widely recognized in current methods for direct gene transfer into hematopoietic stem cells: they are strikingly inefficient, with very large populations transplanted and very few genes surviving to carry out their therapeutic role. Dr. Youssoufian's approach, which he calls "transcellular gene therapy," targets the appropriate cells indirectly instead, exploiting a natural process known as receptor-mediated endocytosis: the protein of interest binds to receptors on the cell surface and then is taken into the cell itself.

Dr. Youssoufian has identified a defective protein, which he has designated as FAC, in at least one subtype of Fanconi anemia. He also has developed a "fusion protein": a macromolecule uniting FAC with interleukin-3, or IL-3. The qualifications of the IL-3 protein for this honor are two: receptors for this protein exist only on hematopoietic cells, and it enters those cells by receptor-mediated endocytosis. Dr. Youssoufian's first transcellular experiment, successful in cell culture, now awaits its turn in mouse models.

Even if it works perfectly, however, the FAC-IL-3 fusion protein could not be used therapeutically, because the number of IL-3 receptors is relatively low—"maybe just a few hundred per cell," Dr. Youssoufian says. He needed another point of entry, and BWF's award is supporting his investigation of several possibilities. One of these, a cell-surface protein known as CD33, "has the right features and is expressed more abundantly than IL-3," he says. But because making proteins is onerous work, and because it brings a risk of immune reactions to the recipient, Dr. Youssoufian is keeping his mind open to other possibilities. "Maybe instead of making the protein in vitro, we will want to package that information in an adenovirus and then have the body make those fusion proteins for us," he muses. "Or maybe instead of targeting adenoviruses to stem cells, we could target them to stromal cells, which are more numerous in bone marrow and are adjacent to the stem cells. Then stromal cells would synthesize and secrete FAC-IL-3 fusion proteins, and because of the IL-3 portion, this fusion protein would stick to the stem cells." Any of these possibilities, if borne out, stands to bring new hope for the treatment of a great many diseases in addition to Fanconi anemia. "Transcellular gene therapy" will be an exciting prospect to watch.

Taking the First Steps

In the spirit of our long-standing commitment to experimental therapeutics and to clinical pharmacology, the Burroughs Wellcome Fund has been at the front of the tide bringing in increased support for clinical research. BWF helped with funding for the critical first meeting of the Association for Patient-Oriented Research and for the Clinical Research Summit project, a series of focus-group and consensus-building discussions held throughout 1998 and 1999 to assess the current state of clinical research and to make recommendations to restore it to full strength.

Acting on one of these recommendations, the Institute of Medicine and the Commission on Life Sciences have established an ongoing Clinical Research Roundtable (CRR) within the National Academy of Sciences. "The CRR promises to be an effective mechanism for focusing national attention on both acute and longer-term issues affecting clinical research, and establishing a visible and accountable process for monitoring the vitality of the clinical research enterprise," says David Korn, M.D., senior vice president for biomedical and health sciences research at the Association of American Medical Colleges.

Along with supporting and participating in wide-ranging discussions on the crisis in clinical research, BWF also was one of the first organizations to do something about it, by establishing the Clinical Scientist Awards in Translational Research program. Now preparing to name its third "class" of awardees, this program provides $750,000 over five years for each of up to 10 U.S. and Canadian physician-scientists working in translational research.

"We're choosing applicants who bring good basic science to patient care," says Judith Swain, M.D., who is the Arthur L. Bloomfield Professor and chair of the Department of Medicine at Stanford University Medical Center, as well as cochair of BWF's advisory committee for the translational research program.

"We really want to support that translational piece—it's an evolution of our former experimental therapeutics program," says BWF President Enriqueta C. Bond, Ph.D. "The area under greatest threat right now seems to be the challenge of keeping the stars in active research. The whole atmosphere of managed care has put pressure on academic centers to invest their faculty's time more in patient care and less in research." BWF's translational research awards are intended to relieve some of this pressure for individuals whose research promises to contribute significantly to medical knowledge. "In order to be really successful in research, you need to be doing it the majority of the time, maybe 80 percent," Dr. Swain estimates. BWF's awards, says Dr. Bond, "buy time from other duties," enabling truly outstanding researchers to continue doing what they do best. The awards are unrestricted and may be used not only to pay part of the researcher's salary but also to hire new staff or even to support animal work that is needed to help accomplish the researcher's goals.

Pamela Davis, M.D., Ph.D., a professor of pediatrics at Case Western Reserve University School of Medicine, served on the advisory committee while the translational research program was evolving from BWF's Scholar Awards in Experimental Therapeutics program. "In its earlier form, the award was modest, and the competition was as well," she says. "But all the time we felt there was a need we weren't tapping. About this time, the idea of the clinical researcher as an endangered species was starting to receive more attention—not that it was a new idea, but there was the sense of a growing crisis. As soon as we declared the focus of our program to be translational research, we saw an immediate increase in the number of applications—and in their quality. This program was an immediate success in the research community." It also has become one of BWF's most competitive programs, with less than one in 10 applicants receiving an award. "We're reaching the 'best and the brightest' scientist-physicians in the country," says Dr. Swain.

Lessons about Lungs

Claire Doerschuk, M.D., spends a lot of time thinking about the human lung, and specifically about inflammation and a white blood cell called the neutrophil. One of three types of granular leukocytes produced by the immune system to protect the body against harmful bacteria, neutrophils are made in the bone marrow and typically spend their short lifetime circulating in the bloodstream, awaiting a call to action.

"The role of the neutrophils is usually beneficial, as in bacterial pneumonia, when they migrate into lung tissue to kill the disease-causing bacteria—but it can also be harmful," Dr. Doerschuk says. An example of the neutrophil function gone awry is the disease known as adult respiratory distress syndrome. This is an out-of-control inflammatory response in the lungs to a major trauma or infection elsewhere in the body, and in approximately 40 percent of cases it proves fatal. Dr. Doerschuk, a professor of pediatrics at Case Western Reserve University School of Medicine, would like to understand more about how neutrophils are recruited from the bone marrow and bloodstream to a site of action in the lungs, because she thinks that in this understanding there is great potential to develop new treatments for common pulmonary diseases.

"Our working hypothesis," she says, "is that the biomechanical properties that enable the spherical neutrophils to squeeze through tiny capillaries in the lungs are the same properties that enabled the neutrophils to be released from bone marrow in the first place. A neutrophil goes from being round to being about 50 percent longer than it is wide, to pass through a capillary in a normal lung; and in the same way, the cell must deform in order to be extruded from bone marrow into the bloodstream."

In theory, these biomechanical properties could be manipulated for clinical purposes, to recruit neutrophils to a site where they are needed (for example, to help fight off antibiotic-resistant bacteria) or to prevent them from overwhelming the body by producing massive inflammation. "We could block or enhance the neutrophil response at various steps: stiffening the cells, intervening in the adhesion of neutrophils to the endothelium, or enhancing deformability," Dr. Doerschuk explains. While continuing to work with human patients, she is exploring these possibilities in various mouse, rat, and rabbit models. "One of our strengths in this work is that we can use so many models," she says with satisfaction.

The long-term objective is to establish a research program focused on interfacing strong basic science research in leukocyte behavior with excellent clinical research. "The ultimate goal," Dr. Doerschuk says, "is the development of novel and creative new therapies for patients with inflammatory lung disease."

The relatively high funding level of this award is important for two reasons, says Dr. Davis: first, because research with human patients is very expensive, and second, because it allows BWF to target applicants who are in midcareer, well established in both the clinical and the research arena. Says Dr. Bond, "If we lose these folks from the system, then there aren't going to be any mentors in the area of translational research—so we would lose not just one generation but perhaps succeeding generations as well." Showing the way for those succeeding generations is an essential function of the award. "We're taking people who are proven mentors and giving them more scope," says Nancy Sung, Ph.D., the BWF program officer who oversees translational research awards. Questions about a candidate's track record as a mentor form an important part of the in-depth interview that takes place during the selection process. "Who is training in your lab? What are they working on? How are you nurturing them? These are questions that are likely to come up in the interview," says Martha Peck, BWF's vice president for programs. "It is important that these applicants have already shown an interest in working with the next generation of physician-scientists, and that they have younger people rotating through their labs."

The importance of mentoring is not just an abstract principle—it is backed up by research (albeit of a somewhat informal nature). As the translational research program got under way, Dr. Sung conceived the idea of surveying each "class" of awardees to see if any patterns emerged among the training backgrounds of these outstanding clinician-scientists. "Since these were people who already were successful, with their careers up and running, we wanted to get at the question of what went into their success," Dr. Sung says. "Now, I have to emphasize that this is a retrospective study, with a small sample size—in short, it's not a true scientific survey. But, in fact, three common factors have emerged." One of these was a relative lack of debt at the time of graduation from medical school, a finding that might be expected, given the financial squeeze that pushes many newly minted M.D.s toward clinically oriented jobs that offer a higher immediate payoff. The other two factors were early exposure to research—in most cases, significant exposure while still in medical school—and having a mentor who conveyed enthusiasm for research itself. Even more important than specific guidance or help, the mentor's clear validation and enjoyment of the day-to-day work of scientific investigation seemed to plant an interest among the mentor's young associates that would later bear fruit in their own research.

Says Dr. Sung, "We want to communicate the results of this informal survey to other funders and to inform organizations that are considering where to put their funding." Clearly, funding that would lower the debt load for medical graduates, and programs that would draw medical students into research and would put them in contact with active physician-scientists as mentors, could each contribute toward improving the picture of translational research.

Forecast for Growth

"Harvesting the fruits of the biotechnology revolution for the benefits of patients" is how Dr. Davis sums up BWF's translational research program, and her formulation rightly leaves the boundaries of translational research open. In Dr. Bond's view, one of the attractive features of the program has been the very rich variety of topics and questions being addressed. The successful applicants themselves, however, do have something strongly in common: they all give promise of continuing major contributions to research that will improve human health. Says Dr. Bond, "I do expect these people to become leaders in their own right: leaders at academic centers, and also in industry."

At BWF, the Clinical Scientist Awards in Translational Research have brought much gratification along with an eagerness to stay open to new opportunities and pressures in research funding. "It's important to say that this is a program in evolution, or in continuous quality improvement—it may need to change over time," says Martha Peck. For the moment, the biggest change in the clinical research arena is represented by the emergence of BWF's program and others along the same lines, both large and small. "We've been so pleased that the idea has been taken up, for example, by the Doris Duke Charitable Foundation, with regard to younger investigators," says Ms. Peck. And Dr. Bond notes that even the National Institutes of Health followed BWF in making new awards available for clinical research. "Foundations usually can move faster and be more catalytic than government agencies," she explains.

The mixture of pride, satisfaction, and optimism that the Burroughs Wellcome Fund feels for this program is expressed simply by Dr. Davis: "We really started a ball rolling on this one, and I think the momentum will continue for a long time."

This report was prepared by Sandra J. Ackerman, a writer based in Durham, North Carolina.

For a list of the recipients of Clinical Scientist Awards in Translational Research, see page 50 in the "Grants Index" section.

For a complete description of this award program, visit BWF's website at www.bwfund.org.

UNDERSTUDIED INFECTIOUS DISEASES: HELP FROM GENOMICS

The advent of genomics is changing the way that science approaches questions of human health. Put simply, genomics is the overarching study of the genetic makeup of humans and other organisms in order to better understand such fundamental matters as the structure and function of individual genes and the way those genes are related and regulated. Doing the experiments that discover genes, as well as doing the experiments that match genes to their protein products, biological structures to life functions, and environmental causes to biological effects, has always been long, slow work, punctuated by sudden brainstorms and hard-won revelations. The availability of complete genomic sequences, the point-by-point "instruction books" that guide cells in performing their tasks, will not replace the hard work of understanding biology, but it will dramatically speed up the rate at which insights become models and models become tested hypotheses.

In recent years, sequencing of the genomes of humans, model organisms like fruit flies and mice, and disease-causing pathogens has proceeded at a remarkable pace. In sequencing, researchers painstakingly work out the order of all the chemical building blocks in an organism's genome. The availability of the rich data resources that derive from sequencing genomes will affect every part of the biomedical enterprise. What questions researchers ask at the bench, how pharmaceutical companies develop drugs, and how physicians evaluate symptoms will all be informed by the availability of the new genetic "roadmaps" and data derived from them. The impact of genomics will spread far beyond the scientific community as well, to affect what children learn about biology in schools and how lawmakers set policies regarding emerging medical issues.

Much of genome sequencing has taken place in industry, by corporations involved in developing drugs and other therapeutic products. But the data from these efforts may not become public for decades, if ever, since opportunities for patenting genes and exploiting newly discovered pathways make possessing genomic information more profitable if the sequence is held secret. For this reason, public and nonprofit funders are sponsoring projects that will place sequence information in the public domain.

Decoding the genetic blueprints of humans and other organisms will affect every part of the biomedical enterprise, and will aid in the development of new drugs and vaccines for a host of devastating diseases.

Of particular importance will be efforts to sequence the genomes of pathogenic organisms that have, for a variety of reasons, remained largely understudied. One major impediment, for example, has been tied to economics: researchers have been reluctant to study—or have been hard pressed to gain funds to study—pathogens that either afflict millions of persons, but primarily in poorer parts of the world, or afflict individuals in both the developing and developed worlds, but in much smaller numbers. These diseases need champions among funders of biomedical research.

The impact of genomics on understanding these diseases will be profound. The availability of sequence data from a wide range of organisms will allow researchers to gain new insight into fundamental biological processes—how, at a molecular level, life works. Analysis of sequence information also will give rapidly applicable advances in combating disease. It will allow identification of new drug targets against scourges that have lacked effective therapies and will stimulate the development of new vaccines.

The Burroughs Wellcome Fund has made a long-term investment in basic science focused on the neglected parasitic diseases of the developing world. Since the 1980s, with the launch of our Scholars Program in Parasitology, BWF has supported dozens of researchers studying malaria, black fever, African sleeping sickness, Chagas disease, and others. In the 1990s, BWF broadened our interest in understudied infectious diseases to include those caused by fungi.

Genetics of Malaria Parasite

In response to the rising global incidence of malaria, BWF has joined with three other funders to support the Malaria Genome Project, an international effort to sequence the entire genetic code of *Plasmodium falciparum*, the major causative agent of the disease. The other funders are the Wellcome Trust, BWF's sister philanthropy in the United Kingdom; the U.S. Department of Defense; and the National Institute of Allergy and Infectious Diseases (NIAID). Begun in 1995, this project is the first to attempt to decipher the genome of a tropical parasite. The funders have dedicated more than $20 million—with BWF contributing more than $7 million—to support efforts ranging from sequencing each of the parasite's 14 chromosomes (the thin strands of DNA contained in the nucleus of cells) to developing new tools for studying expression of newly identified genes.

Progress is coming rapidly. The sequence of chromosome 2 has been determined by scientists at the Institute for Genomic Research (or TIGR), in Maryland, and was published in late 1998 in *Science*. The sequence of chromosome 3, determined by scientists at the Sanger Centre in Cambridge, England, was completed in 1999 and published in *Nature*. Data from the project already have provided new insights into the parasite's biology and have helped identify new candidate proteins that will enter the stream of experiments leading toward production of vaccines to ward off this devastating disease.

The experience of funding this large-scale project has been even more rewarding than BWF had anticipated. Along with the new scientific insight it has provided, the Malaria Genome Project has grown into a model consortium that comprises a collaborative and interactive group able to work with scientists locally and globally. Funders and scientists have developed a strong relationship that allows "just in time" acquisition of resources and an agile, responsive approach to planning. In addition, flexibility in the project's funding has allowed the consortium to take advantage of new technologies and techniques, and to replace outdated or less effective approaches.

Uniquely among sequencing projects, the overall flow of the malaria genome effort has been coordinated by the funders rather than the researchers. Frequent meetings involving funders, researchers focusing on sequencing, and members of the broader malaria research community have served well to keep the far-flung project team focused on the work at hand.

Connections fostered among funders and researchers will be invaluable as the completed sequence provides new opportunities for drug and vaccine development. Workshops held in late 1998 and early 1999 have focused on development of computer tools for public access to malaria information, on development of techniques to improve genetic manipulation of the parasite's genes, and on using several technologies that have become available for studying how genes are turned on and turned off in response to different environmental and growth conditions.

Fighting Fungal Pathogens

The model for funding the Malaria Genome Project also is proving effective in funding the sequencing of the much smaller genome of the fungal pathogen *Candida albicans*. To healthy individuals, this fungus is simply an occasional nuisance—the source of skin rashes and thrush, a mouth infection often seen in children. But to individuals with damaged immune systems—those with AIDS, those who have had an organ transplant, and many cancer patients—*Candida* is an important and dangerous infectious agent. Few drugs are available against *Candida*, and those that do exist have limited efficacy or severe side effects.

In 1996, BWF and the National Institute of Dental and Craniofacial Research (NIDCR; then named the National Institute of Dental Research) cofunded a project to sequence "lightly" the *Candida* genome. The original goal was to generate just enough sequence information to allow researchers to compare the *Candida* genome with the already sequenced genome of its close relative, a yeast called *Saccharomyces cerevisea*. Surprisingly, however, the order of genes in *Candida* turned out to show little overall similarity to gene order in *Saccharomyces*. Expanded funding from NIDCR has since allowed the researchers to more thoroughly sequence the genome, thus providing a better tool for understanding how genes are regulated as the fungus grows inside and outside the human body.

Inspired by such lessons, BWF recently sponsored a handful of small workshops that brought together leaders in the pathogenic mycology community. Designed to stimulate the kind of community-building that has been at the root of the malaria project's success, this modest investment has had exactly the catalytic effect that we seek. Researchers have moved forward from these meetings to form new collaborations, to explore new ideas, and, importantly, to write new grant applications. The National Institute of Allergy and Infectious Diseases recently set its own priorities for extramural funding of pathogen sequencing. *Aspergillus* and *Cryptococcus*, two fungi for which BWF has helped nucleate the research community behind genome projects, are near the top of the list, and NIAID cites these early community-building efforts as a major factor in putting them there.

Lessons for the Future

The collaborative funding of these projects has provided insight for future large-scale projects as well. Such initiatives can be difficult to support when the price tags are higher than even large funders can afford. Good communication and a shared sense of purpose help funders to allocate funding more flexibly, enabling each funding organization to focus on its strengths and build on the efforts of the others.

Organizations like BWF can respond quickly to changes in a project's flow, and thus can be proactive, making small investments that eliminate research obstacles as they arise and enable the project to advance more efficiently. BWF and similar organizations also can "jump start" funding by supporting pilot work during a project's early stages. Such groundwork is essential for the success of complex projects, and it helps attract the support of larger funders.

Taking an early catalytic role, such as in genomics projects, gives foundations an opportunity to exercise a kind of flexible mission-driven funding that can significantly amplify the impact of their dollars.

This report was prepared by Dr. Victoria P. McGovern, BWF program officer.

REPORT ON FINANCE

The Burroughs Wellcome Fund's investments totaled $669.6 million at August 31, 1999, the end of our fiscal year. BWF's primary financial goal is to pursue an investment strategy that will support annual spending needs and maintain a constant real level of assets over the long term. To achieve this goal, substantially all of our investments are placed in U.S. and international capital markets. Hence, fluctuations in BWF's investment results will be due largely to variability in capital market returns.

BWF's investment policies are developed with the recommendations and review of the Investment Committee, which is appointed by and reports to BWF's Board of Directors. The committee, which meets three times a year, has six voting members, including four representatives from outside BWF and two representatives of our board. The board's chair, BWF's president, and BWF's vice president for finance also serve on the committee as nonvoting members.

As part of BWF's investment strategy, we have established "allocation targets"—that is, percentages of our total assets to be invested in particular asset classes. Investment managers hired by BWF pursue more focused mandates within each sector.

As of the end of the fiscal year, BWF's asset mix and market values were:

- U.S. large capitalization equity assets had a market value of $237.1 million. The sector's target allocation was 40 percent, and actual holdings stood at 35.4 percent.
- U.S. small capitalization equity assets had a market value of $103.2 million. The sector's target allocation was 13 percent, and actual holdings stood at 15.4 percent.
- International equity assets had a market value of $173 million. The sector's target allocation was 23 percent, and actual holdings stood at 25.8 percent.
- U.S. fixed income assets had a market value of $128.8 million. The sector's target allocation was 21 percent, and actual holdings stood at 19.2 percent.
- Cash equivalent assets had a market value of $17.1 million. The sector's target allocation was 3 percent, and actual holdings stood at 2.6 percent.
- Alternative assets had a market value of $10.4 million. The sector did not have a target allocation, as this represents a relatively new area of investment; actual holdings stood at 1.6 percent.

The total market value of BWF's investments increased by $117.4 million, or 21.3 percent, from the end of the previous fiscal year. This large increase in assets was due primarily to a strong rebound in worldwide equity markets from the market downturn in August 1998. BWF's total investment return for the fiscal year was 30.1 percent. All three equity asset classes—U.S. large capitalization, U.S. small capitalization, and international—posted returns of greater than 35 percent for the fiscal year.

As of August 31, 1999, BWF employed 10 investment managers. In the U.S. large capitalization equity sector, the managers were Independence Investment Associates; Westpeak Investment Advisors; and Cohen, Klingenstein and Marks. Kennedy Capital Management and Scudder Kemper Investments managed U.S. small capitalization equities. Pacific Investment Management Company and Smith Breeden Associates were the bond managers. Capital Guardian Trust Company and Hansberger Global Investors managed international equities. State Street Global Advisors managed a hedge fund. BWF also held investments in three venture capital funds: Intersouth Partners IV, the Spray Venture Fund, and the North Carolina Bioscience Investment Fund.

Report of Independent Accountants

To the Board of Directors
of the Burroughs Wellcome Fund

In our opinion, the accompanying statements of financial position and the related statements of activities and of cash flows present fairly, in all material respects, the financial position of the Burroughs Wellcome Fund (the "Fund") at August 31, 1999 and 1998, and the changes in its net assets and its cash flows for the years then ended in conformity with generally accepted accounting principles. These financial statements are the responsibility of the Fund's management; our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits of these statements in accordance with generally accepted auditing standards which require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements, assessing the accounting principles used and significant estimates made by management, and evaluating the overall financial statement presentation. We believe that our audits provide a reasonable basis for the opinion expressed above.

Our 1999 audit was conducted for the purpose of forming an opinion on the basic financial statements taken as a whole. The information presented in Schedules I and II is presented for purposes of additional analysis and is not a required part of the basic financial statements. Such information has been subjected to the auditing procedures applied in the audit of the basic financial statements and, in our opinion, is fairly stated in all material respects in relation to the basic financial statements taken as a whole.

PricewaterhouseCoopers LLP

PricewaterhouseCoopers LLP
Raleigh, North Carolina
October 8, 1999

STATEMENTS OF FINANCIAL POSITION

Years Ended August 31, 1999 and 1998

(All dollar amounts presented in thousands)

	1999	1998
ASSETS		
Cash and cash equivalents	$ 36,833	$ 26,541
Marketable securities	643,339	531,751
Accrued interest and dividends receivable	2,798	1,666
Other assets	52	55
Construction-in-progress	11,998	2,435
Total assets	$ 695,020	$ 562,448
LIABILITIES AND NET ASSETS		
Transactions payable, net	$ 11,721	$ 7,103
Accounts payable and other liabilities	1,155	1,257
Unpaid awards	63,395	52,193
Deferred federal excise tax liability	1,579	-
Total liabilities	77,850	60,553
Commitments and contingencies (Note 6)		
Unrestricted net assets	617,170	501,895
Total liabilities and net assets	$ 695,020	$ 562,448

The accompanying notes are an integral part of these financial statements

STATEMENTS OF ACTIVITIES

Years Ended August 31, 1999 and 1998

(All dollar amounts presented in thousands)

	1999	**1998**
Revenues:		
Interest and dividends, less investment expenses of $3,598 and $3,184 in 1999 and 1998, respectively	$ 13,126	$ 14,101
Net realized gain on sales of marketable securities	55,328	61,197
Total revenues	68,454	75,298
Expenses:		
Program services	37,528	34,845
Management and general	5,504	5,479
Total expenses	43,032	40,324
Net unrealized appreciation (depreciation) of marketable securities, net of provision for (benefit from) deferred federal excise taxes of $1,260 and ($1,526) in 1999 and 1998, respectively	89,853	(86,870)
Change in net assets	115,275	(51,896)
Net assets at beginning of year	501,895	553,791
Net assets at end of year	$ 617,170	$ 501,895

The accompanying notes are an integral part of these financial statements

STATEMENTS OF CASH FLOW

Years Ended August 31, 1999 and 1998

(All dollar amounts presented in thousands)

	1999	1998
Cash flows from operating activities:		
Change in net assets	$ 115,275	$ (51,896)
Adjustments to reconcile change in net assets to net cash used in operating activities:		
Depreciation	-	49
Net realized gain on sales of marketable securities	(55,328)	(61,197)
Net unrealized (appreciation) depreciation of marketable securities	(91,113)	88,396
Provision for (benefit from) deferred federal excise taxes	1,579	(1,526)
Awards granted, net of cancellations and change in unamortized discount	37,588	34,931
Award payments made	(26,386)	(22,781)
Increase (decrease) in transactions payable, net	4,618	(8,558)
Increase in accrued interest and dividends receivable	(1,132)	(531)
Decrease (increase) in other assets	3	(40)
(Decrease) increase in accounts payable and other liabilities	(102)	57
Decrease in federal excise taxes payable	-	(99)
Net cash used in operating activities	(14,998)	(23,195)
Cash flows from investing activities:		
Purchases of marketable securities	(1,204,026)	(1,160,261)
Proceeds from sales of marketable securities	1,238,879	1,172,763
Additions to construction-in-progress	(9,563)	(1,962)
Net cash provided by investing activities	25,290	10,540
Net increase (decrease) in cash and cash equivalents	10,292	(12,655)
Cash and cash equivalents at beginning of year	26,541	39,196
Cash and cash equivalents at end of year	$ 36,833	$ 26,541
Supplemental disclosure of cash flow information:		
Cash paid during the year for federal excise taxes	$ 1,418	$ 2,009

The accompanying notes are an integral part of these financial statements

Years Ended August 31, 1999 and 1998
(All dollar amounts presented in thousands)

1. Organization and Summary of Significant Accounting Policies

The Burroughs Wellcome Fund (the "Fund") is a private foundation dedicated to advancing the medical sciences by supporting research and other scientific and educational activities.

Cash equivalents
Cash equivalents are short-term, highly liquid investments that are readily convertible to known amounts of cash and have a maturity of three months or less at the time of purchase.

Forward currency contracts
The Fund enters into financial instruments with off-balance sheet risk in the normal course of its investment activity, primarily forward contracts, to reduce the Fund's exposure to fluctuations in foreign currency exchange rates. These contracts are for delivery or sale of a specified amount of foreign currency at a fixed future date and a fixed exchange rate. Gains or losses on these contracts occur due to fluctuations in exchange rates between the commencement date and the settlement date. Gains and losses on settled contracts are included within "net realized gains or losses on sales of marketable securities," and the changes in market value of open contracts is included within "net unrealized appreciation (depreciation) of marketable securities" in the accompanying statements of activities. It is the Fund's policy to utilize forward contracts to reduce foreign exchange rate risk when foreign-based investment purchases or sales are anticipated.

The contract amount of these forward contracts totaled $488 and $3,740 at August 31, 1999 and 1998, respectively. Realized (losses) gains on forward currency contracts totaled ($143) and $474 in 1999 and 1998, respectively. The market value of open contracts at August 31, 1999 and 1998 was $18 and $133, respectively. The market value is recorded as an asset in the Fund's financial statements. The average fair value of open contracts totaled ($97) and $281 for the years ending August 31, 1999 and 1998, respectively.

Futures contracts
The Fund enters into futures contracts in the normal course of its investment activity to reduce the exposure to interest rate risk associated with bonds and mortgage backed securities. The Fund is required to pledge collateral to enter into these contracts. The amounts pledged for futures contracts at August 31, 1999 and 1998 were $750 and $271, respectively. It is the Fund's intention to terminate these contracts prior to final settlement. Gains and losses on the contracts are settled on a daily basis. Included in transactions payable at August 31, 1999 and 1998 is the net settlement relating to these contracts of ($23) and $80, respectively.

Options
The Fund utilizes options to reduce the exposure to interest rate risk associated with mortgage backed securities. The market value of these options totaled $1,741 and $0 at August 31, 1999 and 1998, respectively, which is recorded as an asset in the Fund's financial statements. The average fair value of open contracts totaled $1,201 and $0 for the years ending August 31, 1999 and 1998. Realized losses on options totaled $4,369 and $0 for the years ending August 31, 1999 and 1998, respectively.

Marketable securities
Marketable securities are carried at estimated market values based on quoted prices. Gains and losses from sales of securities are determined on an average cost basis and are recognized when realized. Changes in the estimated market value of securities are reflected as unrealized appreciation or depreciation in the accompanying statements of activities. The Fund has investment advisors which manage its portfolio of marketable securities. The Fund's management critically evaluates investment advisor performance and compliance with established diversification and investment policies.

Transactions receivable and transactions payable, net
These amounts represent the net receivable or payable resulting from investment transactions with trade dates prior to August 31 and settlement dates subsequent to August 31.

Awards granted and unpaid awards
Grants are expensed at their fair value in the year in which the award is granted. Grants payable over several years are expensed, and carried on the statements of financial position, at the present value of their estimated future cash flows, using a risk free discount rate determined at the time the award is granted.

Functional allocation of expenses
Costs of Fund's operations and activities have been summarized on a functional basis in the statement of activities.

Estimated fair value of financial instruments
Financial instruments include cash and cash equivalents, marketable securities, accrued interest and dividends receivable, accounts payable, and unpaid awards. All financial instruments are reported at their estimated fair value. The carrying values of accrued interest and dividends receivable, accounts payable, and unpaid awards approximate fair values based upon the timing of future expected cash flows. The estimated fair value of marketable securities is determined based upon the latest quoted sales price for such securities as of the balance sheet date. The Fund's remaining assets and liabilities are not considered financial instruments.

Use of estimates
The preparation of financial statements in conformity with generally accepted accounting principles requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

Market risk
Market risk represents the risk of changes in value of a financial instrument, derivative or non-derivative, caused by fluctuations in interest rates, foreign exchange rates and equity prices. The Fund manages these risks by using derivative financial instruments in accordance with established policies and procedures.

New accounting pronouncements
In June 1998, the Financial Accounting Standards Board issued Statement of Financial Accounting Standards ("SFAS") No. 133, "Accounting for Derivative Instruments and Hedging Activities." SFAS No. 133, as amended, is effective for fiscal years beginning after June 15, 2000. SFAS No. 133 requires that all derivative instruments be recorded on the balance sheet at fair value. Changes in the fair value of derivatives are recorded each period in current earnings or other comprehensive income depending on whether a derivative is designated as part of a hedge transaction and, if it is, the type of hedge transaction. Management anticipates that the adoption of SFAS No. 133 will have no material impact on the results of operations or the financial position of the Fund.

2. Construction-in-Progress

Amounts paid by the Fund for construction of a new facility have been capitalized. The total anticipated cost of the new facility is approximately $15,000, and the assets are expected to be placed into service in November 1999.

In October 1997, the Fund entered into a lease agreement for land on which the Fund's new facility is being constructed. The land is being leased from a non-profit North Carolina corporation for a nominal amount through October, 2096. The present value of the contributed asset was not capitalized as the balance would not significantly impact the Statements of Financial Position.

3. Federal Excise Taxes

The Fund is exempt from federal income taxes under Section 501(c)(3) of the Internal Revenue Code. However, since the Fund meets the definition of a private foundation under the Internal Revenue code, it is subject to federal excise tax on its annual net investment income. Deferred federal excise taxes represent the tax liability on unrealized appreciation of marketable securities.

4. Unpaid Awards

Unpaid awards as of August 31 are scheduled for payment as follows:

	1999	1998
Payable in less than one year	$ 28,347	$ 20,180
Payable in one to five years	42,245	38,161
	70,592	58,341
Unamortized discount	(7,197)	(6,148)
Total	$ 63,395	$ 52,193

The expected future liability to the Fund has been calculated based on discount rates ranging from 4.96% to 6.70%.

5. Marketable Securities

The cost and estimated market values of marketable securities at August 31 are as follows:

	1999		1998	
	Cost	Estimated Market Value	Cost	Estimated Market Value
U.S. and foreign governmental obligations	$ 77,092	$ 75,453	$ 108,108	$ 110,354
Corporate bonds	56,184	55,019	39,118	38,857
Common and preferred stocks	284,013	335,282	255,902	256,012
Foreign stocks and foreign equity fund	142,929	173,487	142,136	127,948
Option and forward foreign currency investments	1,042	979	(2,815)	(2,950)
Venture capital investments	3,119	3,119	1,530	1,530
	$ 564,379	$ 643,339	$ 543,979	$ 531,751

6. Commitments

The Fund leases office space under an operating lease with a remaining term of four months. Rental expense for this lease in fiscal 1999 and 1998 was $161 and $123, respectively. Net future minimum lease payments for the remaining term total $55.

7. Employee Benefit and Retirement Plans

The Fund provides medical insurance to all employees working at least thirty hours per week. Coverage extends to each employee's spouse and dependent children, if applicable. The expense for this employee benefit was $88 and $83 during fiscal 1999 and 1998, respectively.

The Fund has a defined-contribution retirement plan covering all employees working at least twenty hours per week. Under the terms of the plan, the Fund matches 50% of all employees' contributions up to 6% of the employee's annual compensation. Employees are 100% vested in employee and employer contributions immediately. The Fund also has a defined-contribution retirement plan funded solely through employer contributions. Under the terms of the plan, the Fund contributes 10% of the employee's annual compensation. This plan covers all employees and vesting in contributions is immediate. The expense for these retirement plans was $38 and $129 in fiscal 1999 and $34 and $115 in fiscal 1998.

8. Classification of Expenses

	1999		1998	
	Program Services	Management and General	Program Services	Management and General
Awards granted, net of cancellations and refunds of $8,773 and $3,664 in 1999 and 1998, respectively	$ 37,528	$ -	$ 34,845	$ -
Federal excise taxes	-	1,418	-	1,910
Salaries and other employee expenses	-	1,772	-	1,555
Travel and entertainment	-	885	-	822
Maintenance and supplies	-	440	-	359
Honoraria	-	347	-	248
Professional fees	-	232	-	284
Printing and design costs	-	132	-	108
Rent	-	161	-	123
Miscellaneous	-	117	-	70
Total expenses	$ 37,528	$ 5,504	$ 34,845	$ 5,479

SCHEDULE I: STATEMENT OF AWARD TRANSACTIONS

Years Ended August 31, 1999

(All dollar amounts presented in thousands)

Unpaid awards, beginning of year	$ 52,193
Add - Awards granted (Schedule II)	47,350
Less - Award payments made	(26,386)
Award cancellations (excluding refunds)	(8,708)
Net increase in unamortized discount	(1,054)
Unpaid awards, end of year	$ 63,395

SCHEDULE II: STATEMENT OF AWARDS GRANTED

Years Ended August 31, 1999

Schedule II information is included in the "Grants Index" beginning on page 30. The dollar amounts listed in this schedule reflect the actual dollar amounts (not rounded to thousands) approved and paid to awardees.

GRANTS INDEX

PROGRAM SUMMARY

	Approved*	Paid**
CAREER DEVELOPMENT OF SCIENTISTS		
Career Awards in the Biomedical Sciences	$ 16,874,993	$ 7,414,034
Hitchings-Elion Fellowships	2,145,186	1,280,309
Life Sciences Research Fellowships	369,000	354,000
BWF Research Travel Grants	503,864	520,439
Other Grants	118,900	175,000
TOTAL	$ 20,011,943	$ 9,743,782
EMERGING INFECTIOUS DISEASES		
Scholar Awards in Molecular Parasitology	$ 850,000	$ 1,005,000
New Investigator Awards in Molecular Parasitology	420,000	817,500
Scholar Awards in Molecular Pathogenic Mycology	1,050,000	825,000
New Investigator Awards in Molecular Pathogenic Mycology	970,000	562,500
New Initiatives in Malaria Research	2,085,000	1,115,000
Other Grants	953,010	474,010
TOTAL	$ 6,328,010	$ 4,799,010
THERAPEUTIC SCIENCES		
Clinical Scientist Awards in Translational Research	$ 7,350,000	$ 2,175,000
New Investigator Awards in the Pharmacological or Toxicological Sciences	2,505,000	1,840,000
Other Grants	129,725	1,767,425
TOTAL	$ 9,984,725	$ 5,782,425
REPRODUCTIVE SCIENCE		
Career Awards in the Biomedical Sciences	$ 1,251,500	$ 266,750
Obstetrics and Gynecology Research Fellowships	144,000	144,000
Reproductive Scientist Development Program Research Grants	240,000	160,000
Other Grants	20,000	120,000
TOTAL	$ 1,655,500	$ 690,750
INTERFACES IN SCIENCE		
Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences	$ 4,804,760	$ 2,248,229
Other Grants	364,686	177,886
TOTAL	$ 5,169,446	$ 2,426,115

	Approved*	Paid**
SCIENCE EDUCATION		
Student Science Enrichment Program	$ 1,210,269	$ 1,085,266
BWF Visiting Professorships in the Basic Medical Sciences	165,000	165,000
BWF Visiting Professorships in the Microbiological Sciences	55,000	50,000
Other Grants	1,378,140	711,040
TOTAL	$ 2,808,409	$ 2,011,306
ENVIRONMENT FOR SCIENCE		
General	$ 1,284,350	$ 724,700
Communications	78,750	138,750
History of Medicine	23,000	19,833
Inactive Programs—Active Awardees of Former Programs	6,000	49,687
TOTAL	$ 1,392,100	$ 932,970
GRAND TOTALS	**$ 47,350,133**	**$ 26,386,358**

* **Approved**—Approved grants are expensed in the fiscal year in which the awards are granted, although the grants may be payable over several years.

** **Paid**—Paid grants represent actual cash outflows during the fiscal year.

Key to Grants Index—BWF makes all awards to nonprofit organizations. For most of the awards listed in the following sections, the individual on whose behalf an award was made is listed first, followed by the name of the awardee's institution, which received the money. For Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences awards, which are made to organizations rather than to individuals, the title of the interfaces program is listed first, followed by the institution or consortium sponsoring the program and the names of the researchers directing the program. For Environment for Science awards, which are made to organizations rather than to individuals, the organization receiving the award is listed first, followed by a brief description of the activity being supported.

TOTAL APPROVED $20,011,943 TOTAL PAID $9,743,782

Career Awards in the Biomedical Sciences

Note: Six additional career awards have been made to scientists working in reproductive science; these awards are described in the "Reproductive Science" section.

** Career awards are postdoctoral-faculty bridging awards, and many recipients change institutions upon obtaining a faculty position. For these awardees, indicated with an asterisk, BWF cancels the original grant to the postdoctoral institution and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the faculty-level grants are listed first and the canceled grants are listed second.*

Ravi Allada, M.D.
Brandeis University
Molecular and genetic analysis of the circadian rhythm gene, *Clock*, in *Drosophila*
Approved $445,000 Paid $29,500

Oscar M. Aparicio, Ph.D.*
University of Southern California
Understanding the relationship of DNA replication to cell cycle control of cellular proliferation and chromosomal organization
Approved $386,000
Massachusetts Institute of Technology
Approved $508,000

Nenad Ban, Ph.D.
Yale University
Determination of the high resolution structure of the large ribosomal subunit
Approved $445,000 Paid $65,500

Gregory J. Beitel, Ph.D.
Stanford University School of Medicine
Mechanisms that control and execute the cell movements and shape changes underlying metazoan morphogenesis
Paid $26,675

Mark Bix, Ph.D.
University of California-San Francisco School of Medicine
Effector CD4$^+$ T cell development: evidence for the stochastic generation and clonal distribution of a combinatorial cytokine repertoire
Paid $29,150

Azad Bonni, M.D., Ph.D.
Harvard Medical School
Regulation of glial fate specification in the central nervous system
Approved $445,000

Edward S. Brodkin, M.D.
Princeton University
Genetic analysis of anxiety-related behaviors in mice
Paid $56,650

Paul S. Buckmaster, D.V.M., Ph.D.
Stanford University School of Medicine
Mechanisms of temporal lobe epilepsy
Paid $115,500

David C. Chan, M.D., Ph.D.
Massachusetts Institute of Technology
Structural and mechanistic studies of virus-mediated membrane fusion
Paid $56,650

Thomas R. Clandinin, Ph.D.
University of California-Los Angeles School of Medicine
Dissecting neuronal target selection in the *Drosophila* visual system
Approved $508,000 Paid $29,500

Michael K. Cooper, M.D.
Johns Hopkins University School of Medicine
Modulation of sonic hedgehog signal transduction by cholesterol homeostasis
Approved $574,000 Paid $29,500

Anita H. Corbett, Ph.D.
Emory University School of Medicine
Components of the nuclear transport system
Paid $118,250

Brendan P. Cormack, Ph.D.
Johns Hopkins University School of Medicine
Virulence determinants of *Candida glabrata*
Paid $115,500

George Q. Daley, M.D., Ph.D.
Massachusetts Institute of Technology
Probing the pathogenesis of chronic myelogenous leukemia
Paid $178,750

Jeanine D'Armiento, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
The role of matrix metalloproteinases in disease
Paid $118,250

Gregory C. DeAngelis, Ph.D.*
Washington University School of Medicine
Neural mechanisms underlying perceptual feature binding
Approved $357,500 Paid $60,500
Stanford University School of Medicine
Paid $29,150

Paul De Koninck, Ph.D.
Stanford University Medical Center
Decoding rhythms in the nervous system
Approved $508,000 Paid $29,500

Jeffrey S. Diamond, Ph.D.
Oregon Health Sciences University
Mechanisms underlying silent synapses: implications for synaptic plasticity in the hippocampus
Paid $56,650

Aaron DiAntonio, M.D., Ph.D.
University of California-Berkeley
Genetic analysis of synapse formation, growth, and plasticity
Paid $56,650

Tamara L. Doering, M.D., Ph.D.
Weill Medical College of Cornell University
GPIs in fungi: biosynthesis and function
Paid $57,750

Michael J. Eck, M.D., Ph.D.
Harvard Medical School
Structural analysis of protein interactions in signal transduction
Paid $82,500

Guowei Fang, Ph.D.
Harvard Medical School
Mechanism of the spindle assembly checkpoint control
Paid $56,650

Steven Fiering, Ph.D.
Dartmouth Medical School
Mutational analysis of the beta-globulin locus control region by homologous recombination
Paid $118,250

Elizabeth A. Finch, Ph.D.
Duke University Medical Center
Postsynaptic calcium signaling by inositol trisphosphate in neuronal dendrites
Approved $445,000 Paid $29,500

Reiko Maki Fitzsimonds, Ph.D.
Yale University School of Medicine
Distributed properties of synaptic plasticity in neural networks
Paid $178,750

Robert C. Flaumenhaft, M.D., Ph.D.
Harvard Medical School
SNARE proteins in platelet alpha-granuale secretion
Approved $386,000

Catherine A. Fox, Ph.D.
University of Wisconsin Medical School
On the formation of domains of gene expression in eukaryotic chromosomes
Paid $60,500

Daved H. Fremont, Ph.D.
Washington University School of Medicine
Structural studies of antigen presentation and T cell activation
Approved $357,500 Paid $178,750

Timothy P. Galitski, Ph.D.
Massachusetts Institute of Technology
Genetic networks
Approved $445,000 Paid $29,500

Jeffrey S. Glenn, M.D., Ph.D.
Stanford University School of Medicine
Prenylation and viral assembly
Paid $56,650

Joseph A. Gogos, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Genetic analysis of connectivity in the mammalian olfactory system
Paid $29,150

Todd R. Golub, M.D.
Harvard Medical School
Models for the molecular pathogenesis of human leukemia
Paid $82,500

Patrick A. Grant, Ph.D.
Pennsylvania State University
Analysis of histone acetyltransferase/transcriptional adaptor complexes in the regulation of gene expression
Approved $445,000 Paid $29,500

Michael Graziano, Ph.D.
Princeton University
From eye to hand: sensory-motor integration in the primate brain
Approved $508,000

Rachel Green, Ph.D.
Johns Hopkins University School of Medicine
Defining the peptidyl transferase center of the ribosome
Paid $115,500

Matthias Gromeier, M.D.
State University of New York-Stony Brook
Principles of polio neuropathogenesis: exploiting poliovirus for the treatment of brain cancer
Approved $445,000 Paid $50,800

Gyorgy Hajnoczky, M.D., Ph.D.
Thomas Jefferson University Jefferson Medical College
Control of cellular function by calcium oscillations
Paid $118,250

Carrie Haskell-Luevano, Ph.D.
University of Florida College of Pharmacy
Determination of the physiological and pharmacological role of the brain specific agouti-related transcript
Approved $357,500 Paid $121,000

Zhigang He, M.D., Ph.D.*
Harvard Medical School
Signaling mechanisms mediating the repulsive effects on developing and regenerating axons
Approved $386,000 Paid $65,500
University of California-San Francisco School of Medicine
Approved $508,000

Xianxin Hua, M.D., Ph.D.
Massachusetts Institute of Technology
Identification and characterization of novel components in the TGF-ß signaling pathway
Paid $56,650

Alan J. Hunt, Ph.D.
University of Michigan
Role of microtubule dynamics in mitotic chromosome movement
Paid $178,750

Jeffry S. Isaacson, Ph.D.
University of Washington School of Medicine
Biophysical properties of presynaptic terminals in the central nervous system
Paid $29,150

Raymond H. Jacobson, Ph.D.
University of California-Berkeley
TBP-related factor and selectivity factor I: probing TBP function in alternative contexts
Paid $29,150

David K. R. Karaolis, Ph.D.
University of Maryland School of Medicine
Pathogenicity islands in the emergence of epidemic and pandemic cholera
Paid $88,000

Suzanne L. Kirby, M.D., Ph.D.
University of North Carolina-Chapel Hill School of Medicine
Proliferative advantage for therapeutic bone marrow
Paid $118,250

Laura J. Knoll, Ph.D.
Stanford University Medical Center
Molecular genetic approaches to investigate developmental regulation in *Toxoplasma gondii*
Approved $508,000 Paid $29,500

Scott C. Kogan, M.D.
University of California-San Francisco School of Medicine
Use of a transgenic mouse model of acute promyelocytic leukemia to elucidate disease pathogenesis and to improve therapy
Paid $27,500

Margarethe J. Kuehn, Ph.D.
Duke University Medical Center
Secretory protein sorting in yeast and bacteria
Paid $115,500

Peter D. Kwong, Ph.D.
Columbia University College of Physicians and Surgeons
An atomic-level investigation of the structure and associated biology of the HIV-envelope protein, gp120
Paid $56,650

Hiten D. Madhani, M.D., Ph.D.
Massachusetts Institute of Technology
Specificity of signal transduction during dimorphic development of yeast
Paid $27,500

Zachary F. Mainen, Ph.D.
Cold Spring Harbor Laboratory
Optical studies of synaptic plasticity mechanisms
Paid $29,150

Kelsey C. Martin, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Communication between the synapse and the nucleus during long-lasting synaptic plasticity
Paid $29,150

Andrea I. McClatchey, Ph.D.
Harvard Medical School
The roles of NF2 tumor suppressor gene product in embryogenesis and tumorigenesis
Paid $118,250

Robert Menard, M.D., Ph.D.
New York University Medical Center
Genetic analysis of malaria sporozoite virulence
Paid $118,250

Chandra Mohan, M.D., Ph.D.
University of Texas Southwestern Medical Center-Dallas
B-cell tolerance and humoral autoimmunity
Approved $374,659 Paid $138,159

Louis J. Muglia, M.D., Ph.D.
Washington University School of Medicine
Adrenal and behavioral responses to stress
Paid $121,000

Charles E. Murry, M.D., Ph.D.
University of Washington School of Medicine
Muscle regeneration after myocardial infarction via gene therapy with MyoD
Paid $82,500

Inke S. Nathke, Ph.D.
University of Dundee
Role of APC/catenin complexes in colon cancer
Paid $118,250

James Olson, M.D., Ph.D.
University of Washington School of Medicine
NeuroD abrogation in neuroblastoma
Paid $29,150

Karen M. Ottemann, Ph.D.*
University of California-Santa Cruz
Chemotaxis in *Helicobacter pylori* and its role in pathogenesis
Approved $357,500 Paid $121,000
University of California-Berkeley
Paid $27,500

George A. Oyler, M.D., Ph.D.
Johns Hopkins University School of Hygiene and Public Health
Signaling pathways of neuronal apoptosis
Paid $52,500

Martin S. Pavelka Jr., Ph.D.*
University of Rochester
Biosynthesis of the mycobacterial cell wall
Approved $357,500 Paid $121,000
Albert Einstein College of Medicine
Approved $19,434

Thomas Perkins, Ph.D.*
Stanford University
Measurements of single DNA-based molecular motors
Approved $508,000 Paid $29,500
Princeton University
Approved $508,000

Martin R. Pollak, M.D.
Harvard Medical School
Mouse molecular genetic studies of the extracellular Ca^{2+}-sensing receptor
Paid $178,750

Salman T. Qureshi, M.D.
McGill University Faculty of Medicine
Genetic analysis of innate resistance to bacterial pathogens
Paid $27,500

Jill Rafael, Ph.D.*
Ohio State University School of Medicine
The role of muscle proteins in synaptic structure and neuromuscular disease
Approved $386,000 Paid $65,500
University of Oxford
Approved $508,000

Ilaria Rebay, Ph.D.
Massachusetts Institute of Technology
Investigation of yan function in Ras1-mediated signal transduction
Paid $118,250

Matthew Redinbo, Ph.D.*
University of North Carolina-Chapel Hill
Structural and functional characterization of human topoisomerase I and the Werner syndrome helicase
Approved $386,000 Paid $65,500
University of Washington
Approved $508,000

David J. Robbins, Ph.D.
University of Cincinnati College of Medicine
Dissecting the hedgehog signal transduction pathway
Paid $118,250

Aimee K. Ryan, Ph.D.
University of California-San Diego
Analysis of inductive events responsible for specification and differentiation of the anterior pituitary gland
Paid $56,650

Sylvia L. Sanders, Ph.D.
Massachusetts Institute of Technology
Analysis of cell-type differences in bud-site selection in *Saccharomyces cerevisiae*
Paid $119,750

Maria A. Schumacher, Ph.D.
Oregon Health Sciences University
Structural biology of cell growth, development, and regulation
Approved $445,000 Paid $29,500

Konstantin V. Severinov, Ph.D.
Rutgers, the State University of New Jersey-Piscataway
RNA polymerase and its subunits: structure and function
Paid $118,250

Krishna V. Shenoy, Ph.D.
California Institute of Technology
Early reach plans in posterior parietal cortex
Approved $508,000 Paid $29,500

Judith A. Shizuru, M.D., Ph.D.
Stanford University School of Medicine
Transplantation of purified allogeneic hematopoietic stem cells: applications for transplantation tolerance induction and the treatment of autoimmune disease
Paid $118,250

Elaine K. Sia, Ph.D.
University of North Carolina-Chapel Hill
Analysis of yeast mutants with altered simple repeat stability
Paid $56,650

Upinder Singh, M.D.
Stanford University School of Medicine
Transcriptional control in *Entamoeba histolytica*
Approved $504,900 Paid $56,650

Barry P. Sleckman, M.D., Ph.D.
Washington University School of Medicine
Lineage specific regulation of T cell receptor beta rearrangement
Approved $357,500 Paid $178,750

Leonidas Stefanis, M.D.
Columbia University College of Physicians and Surgeons
Proteases in neuronal cell death
Paid $118,250

Theodore S. Steiner, M.D.
University of Virginia Health Sciences Center
Isolation and characterization of an interleukin 8 releasing protein from enteroaggregative *Escherichia coli*
Approved $574,000

David J. Sullivan, M.D.
Johns Hopkins University School of Hygiene and Public Health
Iron metabolism in *Plasmodium falciparum*
Paid $115,500

Surachai Supattapone, M.D., D.Phil.
University of California-San Francisco School of Medicine
The structure and biology of a soluble prion
Paid $56,650

Michael J. Thirman, M.D.
University of Chicago Medical Center
Functional analyses of the MLL-ELL fusion transcript in acute leukemia
Paid $117,250

Sarah A. Tishkoff, Ph.D.
Pennsylvania State University
Molecular sequence variation in G6PD and its role in malarial resistance
Paid $56,650

Katharine S. Ullman, Ph.D.
University of Utah
Biochemical dissection of RNA export using in vitro nuclear reconstitution
Approved $357,500 Paid $178,750

Peter C. VanBuren, M.D.
University of Vermont School of Medicine
Role of the thin filament in the altered contractility of heart failure
Paid $118,250

James A. Waddle, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Generation of markers and methods to study asymmetric cell divisions in living *Caenorhabditis elegans* embryos
Approved $357,500 Paid $178,750

Johannes Walter, Ph.D.
University of California-San Diego
Characterization of eukaryotic replication initiation factors using a soluble, cell-free system
Paid $27,500

William A. Weiss, M.D., Ph.D.
University of California-San Francisco School of Medicine
A transgenic model for neuroblastoma
Paid $118,250

Ding Xue, Ph.D.
University of Colorado-Boulder
CED-3/ICE cysteine proteases and their roles in apoptosis
Paid $115,500

Michael Yaffe, M.D., Ph.D.
Harvard Medical School
Scaffolding and chaperone proteins in signal transduction: 14-3-3 regulation of mitosis and programmed cell death
Approved $445,000 Paid $29,500

Cassian Yee, M.D.
University of Washington School of Medicine
Adoptive immunotherapy of melanoma using T cells specific for potential tumor rejection antigens
Paid $178,750

Deborah L. Yelon, Ph.D.
University of California-San Francisco School of Medicine
Patterning during organogenesis: genetic analysis of cardiac chamber formation
Approved $445,000 Paid $29,500

John York, Ph.D.
Duke University Medical Center
Nuclear signal transduction: structure and function
Paid $82,500

SUBTOTALS: Approved $16,874,993 Paid $7,414,034

Hitchings-Elion Fellowships

** Some awardees change institutions during the fiscal year. For these awardees, indicated with an asterisk, BWF cancels the original grant and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the current grants are listed first and the canceled grants are listed second.*

Alison L. Barth, Ph.D.*
University of California-San Francisco School of Medicine
The role of CREB in plasticity within adult somatosensory cortex
Approved $76,550 Paid $52,050
Stanford University
Approved $24,500

Catherine Baty, D.V.M., Ph.D.
University of Oxford
Feline familial hypertrophic cardiomyopathy: a natural model of human familial hypertrophic cardiomyopathy
Approved $3,000 Paid $3,000

Jill R. Beyette, Ph.D.
University of Cincinnati
Genomic molecular genetics of proteasomes
Paid $48,973

Michael W. Black, Ph.D.
Medical Research Council
Secretion-dependent regulation of ribosome synthesis in *Saccharomyces cerevisiae*
Approved $332,500 Paid $34,250

Elena S. Casey, Ph.D.
University of California-Berkeley
Defining the primary targets of Xbra, a transcription factor required for mesodermal patterning in *Xenopus*
Approved $49,000 Paid $24,500

Brian S. DeDecker, Ph.D.*
Harvard Medical School
Structure determination and thermodynamic analysis of mutant p53
Approved $49,000 Paid $49,000
University of Cambridge
Approved $2,625 Paid $2,625

Kevin S. Dingwell, Ph.D.
University of Cambridge
Role of N-cadherin in axon outgrowth
Approved $7,125 Paid $56,125

Aaron R. Dinner, Ph.D.
University of Oxford
The molecular mechanism of free radical oxidative DNA damage
Approved $332,500 Paid $26,750

Francine Durocher, Ph.D.
University of Cambridge
Identifying common low penetrance genes and gene-environment interactions in breast cancer
Approved $7,875 Paid $56,875

Angela K. Eggelston, Ph.D.
Harvard Medical School
Protein-protein interactions involved in holliday junction branch migration and resolution
Approved $51,250 Paid $51,250

John T. Finn, Ph.D.
University College London School of Medicine
Cell-cycle control of cell number in the retina
Approved $4,125 Paid $33,525

FenBiao Gao, Ph.D.
University College London
The control mechanism of oligodendrocyte development in the rodent optic nerve
Approved $636 Paid $636

M. Valerie Gremillion, Ph.D.
University of New Mexico
Realistic computational modeling of the early visual pathways
Approved $49,000 Paid $49,000

Reuben S. Harris, Ph.D.
Medical Research Council
Delineation of the mechanism of immunoglobulin gene hypermutation
Approved $9,000 Paid $33,500

Susan C. Hockings, Ph.D.
University of Leicester
Mechanism of DNA cleavage by DNA gyrase
Paid $49,000

Kenneth A. Johnson, Ph.D.
Rice University
Crystallographic studies of unliganded r-state human hemoglobin
Approved $49,000 Paid $49,000

Steven L. Kazmirski, Ph.D.
University of Cambridge
Structural and dynamical characterization of the folding pathway of the oligomerization domain of p53
Approved $332,500 Paid $53,500

Kenro Kusumi, Ph.D.
Medical Research Council
Genetic analysis of *Hox* regulation in paraxial mesoderm
Approved $7,125 Paid $56,125

Jacqueline L. S. Milne, Ph.D.
Medical Research Council
Structural studies of seven helix cAMP receptors by electron cryo-microscopy
Approved $1,500 Paid $1,500

Stephen C. Ogg, Ph.D.
University of Dundee
Intranuclear transport: factors required for correct subnuclear compartmentalization
Paid $24,500

Jonathan K. Pritchard, Ph.D.
University of Oxford
Population structure and linkage disequilibrium in association mapping
Approved $332,500 Paid $53,500

Jill Rafael, Ph.D.
University of Oxford
The role of utrophin and dystrophin in skeletal muscle and non-muscle tissues
Approved $1,500 Paid $3,500

Laura Rosa Brunet, D.Sc.
University of Cambridge
The role of inflammatory cytokines in the pathogenesis of murine schistosomiasis
Approved $9,000 Paid $61,000

David J. Rossi, Ph.D.
University College London
Mechanisms of ischemia-induced excitotoxicity
Approved $279,000

Jeffrey H. Rothman, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Approaches toward sequence-specific DNA recognition
Paid $22,750

Michael J. Schell, Ph.D.
University of Cambridge
Brain calcium homeostasis: functional roles of GAP1-IP4BP
Approved $6,375 Paid $55,375

Kristin C. Scott, Ph.D.
Medical Research Council
Ectopic silencing in fission yeast
Paid $49,000

Steven P. Smith, Ph.D.
University of Oxford
Interactions of granulocyte-colony-stimulating factor with its receptor at the molecular level
Approved $8,625 Paid $57,625

Dean G. Tang, M.D., Ph.D.
University College London
Role of cell cycle components in timing the oligodendrocyte precursor cell differentiation and senescence
Approved $9,000 Paid $58,000

Yimin Wu, Ph.D.
George Mason University
Protein sorting signals in human malaria parasite *Plasmodium falciparum*
Approved $49,000 Paid $49,000

Lori M. Zeltser, Ph.D.
King's College London
Pattern formation in the avian diencephalon
Approved $54,250 Paid $58,750

Michael E. Zuber, Ph.D.
University of Cambridge
Molecular and cellular interactions required for vertebrate eye field formation
Approved $7,125 Paid $56,125

SUBTOTALS: Approved $2,145,186 Paid $1,280,309

Life Sciences Research Fellowships

These fellowships are administered in partnership with the Life Sciences Research Foundation. BWF awards the primary grant to the foundation, which distributes the funds to the individual awardees.

John A. Berglund, Ph.D. (1998-2001)
University of Colorado-Boulder
Structural studies on the RNA binding protein BBBp and its substrate RNA
Paid $41,000

Enrique M. De La Cruz, Ph.D. (1998-2001)
University of Pennsylvania School of Medicine
Molecular mechanism of myosin 1
Paid $41,000

Marilyn Diaz, Ph.D. (1997-2000)
University of Miami School of Medicine
Do shark lymphocytes bear a single type of antigen receptor?
Paid $36,000

Andrew Dittman, Ph.D. (1997-2000)
University of California-Berkeley
Isolation and analysis of goldfish pheromone receptors
Paid $36,000

Chau V. Huynh, Ph.D. (1999-2002)
Yale University School of Medicine
Intracellular interaction of *Leishmania amazonensis* with host histocompatibility complex (MHC) class II molecules
Approved $123,000 Paid $41,000

Mary Ellen Lane, Ph.D. (1998-2001)
Massachusetts Institute of Technology
Analysis of posterior neural development
Paid $41,000

Jeannine M. Petersen, Ph.D. (1997-2000)
University of Wisconsin Medical School
Understanding mechanisms and control of the nuclear transport pathway
Paid $36,000

Tracy M. Saxton, Ph.D. (1999-2002)
Mount Sinai Hospital
The study of *Evx1* function during mouse development
Approved $123,000 Paid $41,000
(This grant was declined by the awardee after it was approved, and the amount paid was returned to BWF)

Peri Tate, Ph.D. (1999-2002)
University of California-Berkeley
Heterochromatin proteins old and new
Approved $123,000 Paid $41,000

SUBTOTALS: Approved $369,000 Paid $354,000

BWF Research Travel Grants

** Grants are related to history of medicine.*

Julie K. Andersen, Ph.D.
University of Southern California
The role of glutathione in Parkinson's disease
Approved $13,200 Paid $13,200

Byron E. Batteiger, M.D.
Indiana University School of Medicine
Growth cycle dependent expression and localization of effector proteins encoded by a Type III virulence *Chlamydia trachomatis*
Approved $14,842 Paid $14,842

David N. Beratan, Ph.D.
University of Pittsburgh
Electrochemical gradients to chemical bonds: energy transduction in biology
Approved $13,870 Paid $13,870

Paul D. Blanc, M.D.*
University of California-San Francisco School of Medicine
History of technologic change and the ecology of human health
Approved $2,670 Paid $2,670

Susan M. Bornstein-Forst, Ph.D.
Marian College
Studies on the survival and pathogenicity of entomopathogenic nematodes
Approved $15,000

Richard G. Brennan, Ph.D.
Oregon Health Sciences University
Determination of the thermodynamic parameters of the purine repressor purF operator binding by isothermal titration calorimetry
Approved $5,062 Paid $5,062

John D. Cahill, M.D.
Brown University School of Medicine
The incidence of human fecal parasites in Turkana, a district of northwest Kenya
Approved $5,980   Paid $5,980

Alberto Cambrosio, Ph.D.*
McGill University
New biomedical technologies and the transformation of hematology and clinical immunology, 1960 to present
Approved $11,585   Paid $11,585

Daniel B. Carr, M.D.
Tufts University School of Medicine
Support for the Cochrane Collaboration Review Group on Pain, Palliative, and Supportive Care
Approved $3,100   Paid $3,100

Susana Chung, Ph.D.
Indiana University School of Optometry
Mechanism underlying vernier acuity for separated targets: cortical or retinal?
Approved $3,000   Paid $3,000

Eric P. Cohen, M.D.
Medical College of Wisconsin
Glomerulotubular neck stenosis in chronic renal failure
Approved $2,700   Paid $2,700

Daniel Conrad, Ph.D.
Virginia Commonwealth University
Molecular parameters of IgE-CD23 interaction
Approved $4,000   Paid $4,000

Arthur J. L. Cooper, Ph.D., D.Sc.
Weill Medical College of Cornell University
Role of glutathione in neuroprotection and neurotoxicity
Approved $3,600   Paid $3,600

Graham H. Creasey, M.D.
Case Western Reserve University School of Medicine
Development of the sacral anterior root stimulation implant (sarsi) for bladder and bowel control
Approved $12,695   Paid $12,695

David F. Daggett, Ph.D.
University of North Carolina-Chapel Hill
Early signaling during fast muscle specification in the zebrafish embryo
Approved $10,000   Paid $10,000

Lloyd Demetrius, Ph.D.
Massachusetts Institute of Technology
Relationship between protein structure and conformational dimension of the folded state
Paid $10,700

Lloyd Demetrius, Ph.D.
Massachusetts Institute of Technology
Structure-activity relations in protein folding
Approved $10,000   Paid $10,000

Steven A. Forst, Ph.D.
University of Wisconsin-Milwaukee
Cloning and functional analysis of fimA of *Xenorhabdus nematophilus*
Approved $15,000   Paid $15,000

Christopher R. France, Ph.D.
Ohio University
Mechanisms of hypoalgesia in individuals at risk for hypertension
Approved $2,130   Paid $2,130

H. R. Gaskins, Ph.D.
University of Illinois
Toward an understanding of sulfidogenic bacteria and colonic inflammation
Approved $2,700   Paid $2,700

Pamela K. Gilbert, Ph.D.*
University of Florida
Cholera and the mapping of the social body, 1832-66
Approved $2,440   Paid $2,440

Paul D. Gollnick, Ph.D.
State University of New York-Buffalo
Structure function studies of the trp RNA binding attenuation protein
Approved $2,200   Paid $2,200

Robert C. Griggs, M.D.
University of Rochester School of Medicine and Dentistry
International multicenter trials in uncommon muscle diseases
Approved $10,000   Paid $10,000

Geoffrey D. Guttmann, Ph.D.
University of Saskatchewan College of Medicine
Three-dimensional molecular mapping of craniofacial development
Approved $9,365   Paid $9,365

Mark H. Hankin, Ph.D.
Medical College of Ohio
Photoreceptor transplantation in rodent models of retinitis pigmentosa
Approved $12,800   Paid $12,800

Sioban D. Harlow, Ph.D.
University of Michigan School of Public Health
Epidemiology and management of menstrual dysfunction in developing countries
Approved $12,700   Paid $12,700

Graham F. Hatfull, Ph.D.
University of Pittsburgh
Elucidation of the genome structures of bacteriophages and their application for the study of bacterial pathogens
Approved $15,000 Paid $15,000

Ashok N. Hegde, Ph.D.
Columbia University College of Physicians and Surgeons
Olfactory recognition memory: an integrative study
Approved $4,000 Paid $4,000

Jack O. Hensold, M.D.
Case Western Reserve University School of Medicine
Regulation of mRNA polyadenylation during differentiation
Approved $14,950 Paid $14,950

Pui S. Ho, Ph.D.
Oregon State University
The role of non-Watson-Crick interactions in RNA folding
Approved $13,857 Paid $13,857

David W. Horohov, Ph.D.
Louisiana State University School of Veterinary Medicine
Age-associated changes in immune responses in horses
Approved $13,200 Paid $13,200

Walter Huda, Ph.D.
State University of New York Health Science Center-Syracuse
Digital mammography
Approved $6,150 Paid $6,150

Susan Klein, Ph.D.
Indiana University
Radiobiology of relatively low dose irradiation of the eye: clinicopathological and molecular mechanisms
Approved $5,500 Paid $5,500

Ruben I. Kuzniecky, M.D.
University of Alabama-Birmingham School of Medicine
Malformations of brain development: metabolic and functional reorganization studied by magnetic resonance
Paid $10,000

Daniel T. Lackland, Dr.P.H.
Medical University of South Carolina College of Medicine
Assessment of birth weight and chronic disease between South Carolina and U.K. medical beneficiaries
Approved $7,050 Paid $7,050

Ting-Yim Lee, Ph.D.
University of Western Ontario
Measurement of brain blood flow with near infrared spectroscopy
Approved $8,064 Paid $8,064

John C. Lefebvre, Ph.D.
Ohio University
Personality and cognitive correlates of accuracy in the recall of past chronic and acute pain experiences
Approved $3,122 Paid $3,122

Vicky LeGrys, Dr.A.
University of North Carolina-Chapel Hill School of Medicine
Standardization of sweat-testing procedures and neonatal screening protocols for the diagnosis of cystic fibrosis
Approved $10,800 Paid $10,800

Arch G. Mainous, Ph.D.
Medical University of South Carolina College of Medicine
Differences in continuity of medical care in the United States and the United Kingdom
Approved $3,610 Paid $3,610

Joseph L. Mankowski, D.V.M., Ph.D.
Johns Hopkins University School of Medicine
Blood-brain barrier alterations in the SIV/macaque model of AIDS dementia
Approved $4,554 Paid $4,554

J. Richard McIntosh, Ph.D.
University of Colorado-Boulder
Study of mitosis in fission yeasts
Approved $3,550 Paid $3,550

Michael R. McVaugh, Ph.D.*
University of North Carolina-Chapel Hill
Medieval surgical texts: preparing reading editions toward a general history
Approved $20,000 Paid $20,000

Marcia Meldrum, Ph.D.
National Institutes of Health
The pain ladder methodology in pain and palliative medicine
Approved $9,600 Paid $9,600

Joann Moulds, Ph.D.
University of Texas-Houston Health Science Center
Complement receptor one polymorphism and susceptibility to severe malaria
Approved $4,000 Paid $4,000

Christian Naus, Ph.D.
University of Western Ontario
Role of gap junctions in neocortical development
Approved $4,000 Paid $4,000

Margaret A. Nield, Ph.D.
University of California-Los Angeles School of Nursing
Validation of a general health-related quality of life model in people with chronic obstructive pulmonary disease
Approved $5,800 Paid $5,800

Virginia E. Papaioannou, Ph.D.
College of Physicians and Surgeons of Columbia University
Information exchange on t-box genes in development
Approved $11,200   Paid $11,200

Richard P. Phipps, Ph.D.
University of Rochester School of Medicine and Dentistry
Fibroblast immune cell interaction and activation in the reproductive system
Approved $11,150   Paid $11,150

Michael E. Rhodes, Ph.D.
Allegheny University of the Health Sciences
Sex steroid control of central serotonergic neurotransmission: effects of monamine turnover in forebrain
Approved $3,626   Paid $3,626

Peter G. Satir, Ph.D.
Albert Einstein College of Medicine
Computer modeling of ciliary structures and mechanisms
Approved $2,250   Paid $2,250

James Scheuer, M.D.
Albert Einstein College of Medicine
Isolated myocardial cell physiology and metabolism
Approved $15,000   Paid $15,000

L. David Sibley, Ph.D.
Washington University School of Medicine
Genetic mapping in *Toxoplasma*
Approved $4,125

Arnold Sladen, M.D.*
University of North Carolina-Chapel Hill School of Medicine
The rise and fall of pulse-lore in clinical medical practice
Approved $3,600   Paid $3,600

Gerald R. Smith, Ph.D.
University of Washington
Genetic and cytological analysis of fission yeast
Approved $15,000   Paid $15,000

Sylvia Smith, Ph.D.
Florida International University College of Health
Characterization of complement proteins and antibacterial peptides of the shark
Approved $14,500   Paid $14,500

John L. Spudich, Ph.D.
University of Texas-Houston Health Science Center
Molecular structure of a signal transduction complex
Approved $15,000   Paid $15,000

Lawrence Stern, Ph.D.
Massachusetts Institute of Technology
Novel oligomeric MHC peptide complexes as specific T cell direction reagents
Approved $4,400   Paid $4,400

Leslie M. Thompson, Ph.D.
University of California-Irvine College of Medicine
Triplet repeat pathogenesis in *Drosophila:* electron microscopy studies
Approved $2,900   Paid $2,900

James Tomasek, Ph.D.
University of Oklahoma Health Sciences Center
Extracellular and intracellular signals responsible for tensional homeostasis in fibroblasts
Approved $14,600   Paid $14,600

Dennis A. Turner, M.D.
Duke University Medical Center
Mechanisms of epileptogenesis and plasticity after hippocampal kainic acid lesions
Approved $6,810   Paid $6,810

Samuel Weiss, Ph.D.
University of Calgary Faculty of Medicine
POU-III gene function in zebrafish neural development
Paid $15,000

George Weisz, Ph.D.*
McGill University Faculty of Medicine
The history of medical specialization in Great Britain, 1800-1960
Approved $5,885   Paid $5,885

Alan Wells, M.D., D.M.S.
University of Alabama-Birmingham
Rho signaling in cell motility: a role in stabilizing the leading edge?
Approved $13,177   Paid $13,177

Philip Yeagle, Ph.D.
University of Connecticut
Three-dimensional structure of a G-protein coupled receptor
Approved $3,195   Paid $3,195

SUBTOTALS: Approved $503,864   Paid $520,439

Other Grants

Wellcome Trust Travel Grants

These grants are made by the Wellcome Trust, BWF's sister philanthropy in the United Kingdom, to support visits by U.K. and Irish researchers to the United States. BWF makes grants to the host institutions as a contribution to expenses incurred during the visit.

Harvard Medical School
N. P. J. Brindle
University of Leicester
The roles of PTPs in the control of vascular development
Approved $1,000   Paid $1,000

Rockefeller University
M. C. Field
Imperial College of Science, Technology, and Medicine
Reconstitution of nuclear import in vitro in a parasitic protozoan
Paid $1,000

University of Rhode Island
Darrell D. Brooks
University of Central Lancashire
Collaborative research with Professor R. B. Hill
Approved $1,000   Paid $1,000

University of Washington
John R. Garrett
King's College School of Medicine and Dentistry
Salivary glandular function
Approved $1,000   Paid $1,000

Environment for Science

In addition to our competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

American Association for the Advancement of Science
Support for the Career Development Resource Center, a Web-based site for young research scientists
Approved $73,200   Paid $43,600

Commission on Professionals in Science and Technology
Support for postdoctoral fellows to participate at the Association of American Medical Colleges' Group on Graduate Research, Education, and Training (GREAT) annual conference
Approved $12,700   Paid $12,700

National Academy of Sciences
Support for the development and distribution of a guidebook on the postdoctoral experience
Approved $30,000

Radcliffe College
Support for biomedical fellowships for postdoctoral women scientists
Paid $114,700

SUBTOTALS: Approved $118,900   Paid $175,000

TOTAL APPROVED $6,328,010 TOTAL PAID $4,799,010

Scholar Awards in Molecular Parasitology

Norma W. Andrews, Ph.D.
Yale University School of Medicine
The role of lysosome exocytosis in the cell invasion mechanism of *Trypanosoma cruzi*
Paid $80,000

Daniel Goldberg, M.D., Ph.D.
Washington University School of Medicine
Hemoglobin metabolism in *Plasmodium falciparum*
Paid $80,000

Anthony A. James, Ph.D.
University of California-Irvine
Reduction of the transmission of vector-borne diseases by genetic manipulation of vector arthropods
Paid $60,000

Patricia J. Johnson, Ph.D.
University of California-Los Angeles School of Medicine
Investigation of potential chemotherapeutic targets and the pathogenesis of the human-infective parasite *Trichomonas vaginalis*
Paid $80,000

Keith A. Joiner, M.D.
Yale University School of Medicine
A molecular analysis of secretion in *Toxoplasma gondii*
Paid $80,000

Scott M. Landfear, Ph.D.
Oregon Health Sciences University School of Medicine
Biology of membrane transporters in *Leishmania* parasites
Paid $80,000

James H. McKerrow, M.D., Ph.D.
University of California-San Francisco School of Medicine
Parasite proteases: analysis of structure-function relationships and structure-based drug design
Paid $80,000

William Petri Jr., M.D., Ph.D.
University of Virginia Health Sciences Center
Adherence and cytolysis by *Entamoeba histolytica*
Paid $80,000

Margaret A. Phillips, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Design of inhibitors for *Trypanosoma brucei* ornithine decarboxylase using a combination of structure-based approaches and combinatorial chemistry
Approved $425,000 Paid $42,500

David S. Roos, Ph.D.
University of Pennsylvania
Exploring the function of the apicomplexan plastid
Paid $80,000

David G. Russell, Ph.D.
Washington University School of Medicine
Molecular mechanisms employed by *Leishmania* and *Mycobacterium* to ensure their continued success as intramacrophage parasites
Paid $60,000

Samuel L. Stanley, M.D.
Washington University School of Medicine
Pathways for amebic induction of inflammation and programmed cell death
Approved $425,000 Paid $42,500

Rick L. Tarleton, Ph.D.
University of Georgia
Immunity and disease in *Trypanosoma cruzi* infection
Paid $80,000

Elisabetta Ullu, Ph.D.
Yale University School of Medicine
A molecular analysis of the nucleus in *Trypanosoma brucei*
Paid $80,000

SUBTOTALS: Approved $850,000 Paid $1,005,000

New Investigator Awards in Molecular Parasitology

John H. Adams, Ph.D.
University of Notre Dame
Molecular analysis of the malaria merozoite apical complex
Paid $65,000

James D. Bangs, Ph.D.
University of Wisconsin Medical School
Secretory and endocytic trafficking in *Trypanosoma brucei*
Paid $65,000

Cornelis J. Beckers, Ph.D.
University of Alabama-Birmingham School of Medicine
The role of cytoplasmic calcium in the regulation of motility and host cell invasion by *Toxoplasma gondii*
Paid $65,000

Vivian M. Bellofatto, Ph.D.
University of Medicine and Dentistry of New Jersey-New Jersey Medical School
Molecular analysis of trypanosome gene transcription
Paid $65,000

Michael Cappello, M.D.
Yale University School of Medicine
The molecular pathogenesis of hookworm anemia
Approved $210,000 Paid $35,000

Christopher A. Hunter, Ph.D.
University of Pennsylvania School of Veterinary Medicine
Role of accessory molecules in the regulation of natural killer responses during infection
Paid $65,000

Stuart J. Kahn, M.D.
University of Washington School of Medicine
The analysis of the naive T-cell response to the surface glycoprotein superfamily of *Trypanosoma cruzi*
Paid $65,000

Kami Kim, M.D.
Albert Einstein College of Medicine
Signaling pathways and *Toxoplasma gondii* differentiation
Paid $65,000

Jonathan H. LeBowitz, Ph.D.
Purdue University
Structure and function of the *Leishmania* paraflagellar rod
Paid $65,000

Gwo-Shu M. Lee, Ph.D.
New York University Medical Center
The flagellar pocket proteins of African trypanosomes
Paid $32,500

Silvia N. J. Moreno, Ph.D.
University of Illinois at Urbana-Champaign College of Veterinary Medicine
Pyrophosphate metabolism in *Toxoplasma gondii*
Approved $210,000 Paid $35,000

Martin Olivier, Ph.D.
Laval University Faculty of Medicine
Role of the macrophage protein tyrosine phosphatase SHP-1 in *Leishmania* pathogenesis
Paid $65,000

Marc Ouellette, Ph.D.
Laval University Faculty of Medicine
Drug resistance mechanisms in *Leishmania*
Paid $32,500

Eric Pearlman, Ph.D.
Case Western Reserve University School of Medicine
Cell recruitment in helminth-induced allergic inflammation
Paid $65,000

Laurie K. Read, Ph.D.
State University of New York-Buffalo
Mitochondrial RNA processing in *Trypanosoma brucei*
Paid $32,500

SUBTOTALS: Approved $420,000 Paid $817,500

Scholar Awards in Molecular Pathogenic Mycology

Martin Bard, Ph.D.
Indiana University-Purdue University at Indianapolis
Characterization of new target sites for antifungal intervention in the *Candida albicans* ergosterol pathway
Approved $425,000 Paid $42,500

Judith Berman, Ph.D.
University of Minnesota
Use of *Saccharomyces cerevisiae* to study molecular mechanisms of *Candida albicans* pathogenicity
Paid $80,000

William A. Fonzi, Ph.D.
Georgetown University Medical Center
Environmental signals and virulence of *Candida albicans*
Paid $80,000

William E. Goldman, Ph.D.
Washington University School of Medicine
Probing the parasitic lifestyle of *Histoplasma capsulatum*
Paid $80,000

Joseph Heitman, M.D., Ph.D.
Duke University Medical Center
Signal transduction pathways regulating virulence of *Cryptococcus neoformans*
Paid $80,000

Alexander D. Johnson, Ph.D.
University of California-San Francisco School of Medicine
Analysis of a mating-type-like locus in *Candida albicans*
Approved $200,000   Paid $20,000

Elizabeth J. Keath, Ph.D.
Saint Louis University
Novel molecular and DNA vaccine approaches to *Histoplasma capsulatum*
Paid $80,000

Bruce Klein, M.D.
University of Wisconsin Medical School
Genetic immunization against pathogenic fungi
Paid $80,000

James W. Kronstad, Ph.D.
University of British Columbia
Temperature-regulated and infection-regulated gene expression in *Cryptococcus neoformans*
Approved $425,000   Paid $42,500

Stuart M. Levitz, M.D.
Boston University School of Medicine
Use of molecular biology to identify *Cryptococcus neoformans* antigens that stimulate cell-mediated immunity
Paid $80,000

Aaron P. Mitchell, Ph.D.
Columbia University College of Physicians and Surgeons
Analysis of the *Candida* CaRIM transduction pathway
Paid $80,000

Peter A. B. Orlean, Ph.D.
University of Illinois at Urbana-Champaign
Glycolipid anchoring of protein and wall biogenesis in fungal pathogens
Paid $80,000

SUBTOTALS: Approved $1,050,000   Paid $825,000

New Investigator Awards in Molecular Pathogenic Mycology

** Some awardees change institutions during the fiscal year. For these awardees, indicated with an asterisk, BWF cancels the original grant and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the current grants are listed first and the canceled grants are listed second.*

Kent L. Buchanan, Ph.D.*
Tulane University Medical Center
Acquired host resistance in cryptococcal meningitis
Approved $130,000   Paid $32,500
University of Oklahoma Health Sciences Center
Paid $32,500

Gary M. Cox, M.D.
Duke University Medical Center
Antisense repression in *Cryptococcus neoformans*
Approved $210,000   Paid $35,000

Scott G. Filler, M.D.
University of California-Los Angeles School of Medicine
Stimulation of endothelial cells in *Candida albicans*
Approved $210,000   Paid $35,000

Gary B. Huffnagle, Ph.D.
University of Michigan Medical Center
The role of melanin production by *Cryptococcus neoformans* in evasion of host defenses
Paid $65,000

Haoping Liu, Ph.D.
University of California-Irvine College of Medicine
Regulation of dimorphism in *Candida albicans*
Paid $32,500

Jennifer K. Lodge, Ph.D.
Saint Louis University School of Medicine
Identification of virulence-related determinants in *Cryptococcus neoformans*
Paid $65,000

Michelle C. Momany, Ph.D.
University of Georgia
Identification of novel cell wall components in *Aspergillus fumigatus*
Paid $65,000

Anita Sil, M.D., Ph.D.
University of California-San Francisco School of Medicine
A genetic analysis of pathogenesis in *Histoplasma capsulatum*
Approved $210,000 Paid $35,000

A. George Smulian, M.B., B.Ch.
University of Cincinnati College of Medicine
The role of MAP kinase Mkp1 in the regulation of cell wall synthesis in *Pneumocystis carinii*
Approved $210,000 Paid $35,000

Theodore C. White, Ph.D.
University of Washington School of Public Health and Community Medicine
Transcriptional regulation of drug resistance in *Candida albicans*
Paid $65,000

Brian L. Wickes, Ph.D.
University of Texas Health Science Center-San Antonio
Identification of mating type-associated antifungal targets in *Cryptococcus neoformans*
Paid $65,000

SUBTOTALS: Approved $970,000 Paid $562,500

New Initiatives in Malaria Research

** Some awardees change institutions during the fiscal year. For these awardees, indicated with an asterisk, BWF cancels the original grant and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the current grants are listed first and the canceled grants are listed second.*

James P. Allen, Ph.D.
Elizabeth J. Davidson, Ph.D.
Arizona State University
Structure-based design of mosquitocidal toxins
Approved $100,000 Paid $25,000

Russ B. Altman, M.D., Ph.D.
Stanford University School of Medicine
A knowledge base of biological function for malaria
Approved $400,000 Paid $50,000

Sailen Barik, Ph.D.
University of South Alabama College of Medicine
Signal transduction in *Plasmodium*
Approved $100,000 Paid $25,000

John B. Dame, Ph.D.
University of Florida College of Veterinary Medicine
Thomas C. Rowe, Ph.D.
University of Florida College of Medicine
Discovery of a novel malarial DNA gyrase and its development as a drug target
Approved $200,000 Paid $50,000

Roberto Docampo, M.D., Ph.D.
University of Illinois at Urbana-Champaign College of Veterinary Medicine
Acidocalcisomes in *Plasmodium*
Approved $100,000 Paid $25,000

Jonathan A. Ellman, Ph.D.
University of California-Berkeley
Irwin D. Kuntz, Ph.D.
University of California-San Francisco School of Pharmacy
Inhibitors of plasmepsin II for malaria treatment
Paid $100,000

Channe D. Gowda, Ph.D.
Georgetown University Medical Center
Christian Ockenhouse, M.D., Ph.D.
Walter Reed Army Institute of Research
Maternal malaria and chondroitin sulfate proteoglycans of human placenta
Paid $50,000

Kasturi Haldar, Ph.D.*
Northwestern University Medical School
Secretory targeting signals in *Plasmodia*
Approved $150,000 Paid $75,000
Stanford University School of Medicine
Paid $25,000

Christopher A. Hunter, Ph.D.
University of Pennsylvania School of Veterinary Medicine
Role of $NF_K B$ in resistance to malaria
Approved $100,000 Paid $25,000

James W. Kazura, M.D.
Case Western Reserve University School of Medicine
Nicholas Schork, Ph.D.
Case Western Reserve University
Genetic dissection of malaria morbidity
Paid $100,000

Walter H. Lewis, Ph.D.
Washington University
Daniel E. Goldberg, M.D., Ph.D.
Washington University School of Medicine
Optimizing the search for new antimalarial therapeutics
Approved $400,000 Paid $50,000

Thomas V. McDonald, M.D.
Albert Einstein College of Medicine
K^+ channels as therapeutic targets in malaria
Approved $100,000 Paid $25,000

Victor Nussenzweig, M.D.
Ruth Nussenzweig, M.D., Ph.D.
New York University Medical Center
The function of sporozoite membrane proteins investigated in genetically engineered malaria parasites
Paid $100,000

Michael C. Pirrung, Ph.D.
Alvin L. Crumbliss, Ph.D.
Duke University
Orally available iron chelators as antimalarials
Paid $50,000

Pradipsinh K. Rathod, Ph.D.
Catholic University of America
Accelerated drug resistance in *Plasmodium falciparum*
Paid $100,000

Paul D. Roepe, Ph.D.
Georgetown University
James A. Martiney, Ph.D.
Kenneth S. Warren Laboratories
Single-cell photometric analysis of drug-resistant malaria
Approved $235,000 Paid $40,000

Mary M. Stevenson, Ph.D.
Philippe Gros, Ph.D.
McGill University Faculty of Medicine
Genetic and functional dissection of susceptibility to malaria
Paid $100,000

Dyann F. Wirth, Ph.D.
Harvard School of Public Health
The *Plasmodium falciparum* transcriptome: analysis of drug response
Approved $200,000 Paid $50,000

Liangbiao Zheng, Ph.D.
Yale University School of Medicine
Positional approach to clone *Pen1* from *Anopheles gambiae*
Paid $50,000

SUBTOTALS: Approved $2,085,000 Paid $1,115,000

Other Grants

Environment for Science

In addition to our competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Cold Spring Harbor Laboratory
Support for speakers and for participation of young investigators at meeting titled "Microbial Pathogenesis and Host Response"
Approved $5,000

Foundation for Advanced Education in the Sciences Inc.
Support for the Burroughs Wellcome/NIAID/Biology of Parasitic Infection Lecture Series
Approved $5,000 Paid $5,000

Genetics Society of America
Support for the Twentieth Fungal Genetics Conference
Approved $10,000 Paid $10,000

Georgetown University Medical Center
Support for the Fifth International Meeting on *Candida* and Candidiasis
Paid $10,000

Gordon Research Conferences
Support for the Conference on Parasitism
Approved $15,000 Paid $15,000

Institute for Genomic Research
Support for the application of DNA microarrays to determine gene expression in *Plasmodium falciparum*
Approved $48,135 Paid $48,135

Malaria Foundation International
Support for the Multilateral Initiative on Malaria's African Malaria Conference
Approved $25,000 Paid $25,000

Marine Biological Laboratory
Support for the Third Woods Hole Immunoparasitology Meeting
Approved $10,000 Paid $10,000

Marine Biological Laboratory
Support for the training course Biology of Parasitism, to cover a four-year period from 1999 to 2003
Approved $600,000   Paid $75,000

Marine Biological Laboratory
Support for the training course Molecular Mycology: Current Approaches to Fungal Pathogenesis
Paid $100,000

Medical College of Wisconsin
Support for a symposium titled "Medicine in the 21st Century: Meeting the Genomic Challenge," held at the American Association for the Advancement of Science annual meeting
Approved $2,500   Paid $2,500

Midwest Microbial Pathogenesis Meeting
Support for the sixth annual meeting
Approved $4,000

New York University School of Medicine
Support for optically mapping *Trypanosoma brucei rhodesiense*
Approved $150,000

Saint Louis University School of Medicine
Support for a meeting to organize the sequencing of the *Cryptococcus neoformans* genome
Approved $13,000   Paid $13,000

Smith College
Support for publication of the proceedings of a symposium titled "Evolutionary Relationships among Eukaryotes"
Approved $2,500   Paid $2,500

Stanford University School of Medicine
Support for sequencing the *Candida albicans* genome
Paid $100,000

Texas A&M University
Support for a predoctoral fellow to analyze the *Plasmodium falciparum* genome and to develop Web-based tools for malaria research
Approved $22,000   Paid $22,000

Toxoplasmosis Research Institute
Support for the Fifth International *Toxoplasma* Conference
Approved $7,500   Paid $7,500

Tulane University
Support for an organizational meeting of researchers on *Aspergillus* to discuss genomics
Approved $15,375   Paid $15,375

University of Cincinnati
Support for the Society of Protozoologists' Sixth International Workshops on Opportunistic Protists
Approved $5,000   Paid $5,000

University of Notre Dame
Support for Kenyan student Eunita Ohas to obtain graduate training in the United States with BWF awardee John Adams, Ph.D.
Approved $8,000   Paid $8,000

Walter and Eliza Hall Institute of Medical Research
Support for an international meeting titled "Molecular Approaches to Malaria Research"
Approved $5,000

SUBTOTALS: Approved $953,010   Paid $474,010

TOTAL APPROVED $9,984,725 TOTAL PAID $5,782,425

Clinical Scientist Awards in Translational Research

** Some awardees change institutions during the fiscal year. For these awardees, indicated with an asterisk, BWF cancels the original grant and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the current grants are listed first and the canceled grants are listed second.*

Nina Bhardwaj, M.D., Ph.D.
Rockefeller University
Vaccination of HIV-1 positive individuals by antigen-pulsed dendritic cells
Approved $750,000 Paid $75,000

Gilbert Chu, M.D., Ph.D.
Stanford University Medical Center
Cancer treatment by genome-wide transcription scanning
Paid $150,000

Claire M. Doerschuk, M.D.
Harvard School of Public Health
The response of neutrophils during inflammatory lung disease
Paid $150,000

Robert W. Doms, M.D., Ph.D.
University of Pennsylvania School of Medicine
Chemokine receptors as new targets for HIV-1 therapeutics
Paid $150,000

Erol Fikrig, M.D.
Yale University School of Medicine
Borrelia gene expression and lyme arthritis
Paid $150,000

Eva Guinan, M.D.
Harvard Medical School
Extending the donor pool by inducing alloantigen specific T cell anergy ex vivo for human hematopoietic stem cell transplantation
Approved $750,000 Paid $75,000

Barbara Hempstead, M.D., Ph.D.
Weill Medical College of Cornell University
Growth factor regulation of coronary angiogenesis
Approved $750,000 Paid $75,000

Alex E. MacKenzie, M.D., Ph.D.
University of Ottawa Faculty of Medicine
The cytoprotective NAIP and XIAP genes: identification of activation pathways and inducing agents
Paid $150,000

Jason D. Morrow, M.D.
Vanderbilt University Medical Center
The isoprostanes as markers and mediators of oxidant stress in humans
Approved $750,000 Paid $75,000

W. Edward Robinson Jr., M.D., Ph.D.
University of California-Irvine College of Medicine
Structure-function analyses of clinically relevant HIV integrases
Approved $750,000 Paid $75,000

Howard A. Rockman, M.D.*
Duke University Medical Center
Novel molecular therapeutic strategies in heart failure: role of beta-adrenergic receptor desensitization
Approved $600,000 Paid $75,000
University of North Carolina-Chapel Hill School of Medicine
Paid $75,000

Antony Rosen, M.B., Ch.B.
Johns Hopkins University School of Medicine
Altered structure and clearance of autoantigens during apoptosis: implications for autoimmunity
Approved $750,000 Paid $75,000

Christian W. Schindler, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Intervention of IL-5 signaling: a therapeutic paradigm for asthma
Paid $150,000

Ann Marie Schmidt, M.D.
Columbia University College of Physicians and Surgeons
Novel therapeutic strategy for the prevention and treatment of diabetic complications: antagonism of receptor for advanced glycation end products
Approved $750,000 Paid $75,000

Mark H. Siegelman, M.D., Ph.D.
University of Texas Southwestern Medical Center-Dallas
Functionally activated lymphocyte CD44 in the initiation and perpetuation of autoimmune disease
Approved $750,000 Paid $75,000

Joyce M. Slingerland, M.D., Ph.D.
University of Toronto Faculty of Medicine
Resistance to tamoxifen: a consequence of altered $p27^{Kip1}$ regulation during breast cancer progression
Paid $150,000

Dennis J. Templeton, M.D., Ph.D.
Case Western Reserve University School of Medicine
Stress signaling inhibitors potentiate genotoxin-induced apoptosis in a human colon tumor model
Approved $750,000   Paid $75,000

Mark J. Yeager, M.D., Ph.D.
Scripps Research Institute
Structure and function of cardiac gap junction membrane channels
Paid $150,000

Hagop Youssoufian, M.D.
Baylor College of Medicine
Transcellular gene therapy: application to Fanconi anemia
Paid $150,000

SUBTOTALS: Approved $7,350,000   Paid $2,175,000

New Investigator Awards in the Pharmacological or Toxicological Sciences

** Some awardees change institutions during the fiscal year. For these awardees, indicated with an asterisk, BWF cancels the original grant and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the current grants are listed first and the canceled grants are listed second.*

Pharmacological Sciences

Lee S. Bardwell, Ph.D.
University of California-Irvine
Novel roles for protein-protein interactions in mitogen-activated protein kinase signaling
Approved $210,000   Paid $35,000

Carolyn R. Bertozzi, Ph.D.
University of California-Berkeley
Engineering novel cell surface chemistry for selective tumor cell targeting
Paid $65,000

Charles M. Brenner, Ph.D.
Thomas Jefferson University Jefferson Medical College
A genomic approach to identify chemotherapeutic targets
Paid $65,000

Kathleen Collins, Ph.D.
University of California-Berkeley
Biochemical and structural characterization of recombinant *Tetrahymena* telomerase
Paid $65,000

Craig M. Crews, Ph.D.
Yale University School of Medicine
Exploring the pharmaceutical potential of PKC isozyme regulation using combinatorial chemistry
Paid $32,500

Cynthia Czajkowski, Ph.D.
University of Wisconsin Medical School
Molecular determination of the benzodiazepine and GABA binding sites of the $GABA_A$ receptor
Paid $32,500

Graeme W. Davis, Ph.D.
University of California-San Francisco School of Medicine
Molecular and genetic analysis of synaptic homeostasis
Approved $210,000   Paid $35,000

Raymond J. Deshaies, Ph.D.
California Institute of Technology
Ubiquitin-dependent proteolysis
Paid $65,000

Haian Fu, Ph.D.
Emory University School of Medicine
Role of 14-3-3 proteins in signal transduction and oncogenesis
Paid $32,500

Bruce A. Hay, Ph.D.
California Institute of Technology
Identification and characterization of regulators of caspase-dependent cell death signaling
Paid $65,000

Linda A. Hicke, Ph.D.
Northwestern University
Ubiquitin-dependent internalization and degradation of signal transducing receptors
Paid $65,000

Kevin R. Jones, Ph.D.
University of Colorado-Boulder
Function of brain-derived neurotrophic factor in the basal ganglia
Paid $32,500

Kerry Kornfeld, M.D., Ph.D.
Washington University School of Medicine
Sar-5, a novel negative regulator of Ras signaling
Paid $65,000

Wendell Lim, Ph.D.
University of California-San Francisco School of Medicine
Protein recognition in signal transduction: the structural and energetic basis of complex SH3 domain mediated interactions
Paid $65,000

Andres V. Maricq, M.D., Ph.D.
University of Utah
Dominant activation of neurons: a genetic approach to uncover mechanisms of neuronal signaling and control of behavior
Approved $210,000 Paid $35,000

Stephen Michnick, Ph.D.
University of Montreal Faculty of Medicine
Protein-fragment complementation assays: a general strategy for identifying relationships among proteins in vivo
Paid $65,000

Garry P. Nolan, Ph.D.
Stanford University School of Medicine
Dominant negative effectors of differentiation and intracellular signaling
Paid $32,500

Rama Ranganathan, M.D., Ph.D.
University of Texas Southwestern Medical Center-Dallas
Assembly and function of multi-protein complexes in visual signaling
Paid $57,500

Ram Sasisekharan, Ph.D.
Massachusetts Institute of Technology
Heparin-like glycosaminoglycans as a target for therapeutic intervention
Approved $210,000 Paid $35,000

Natalie C. Strynadka, Ph.D.
University of British Columbia Faculty of Medicine
Antibiotic discovery targeting essential proteins on the bacterial outer membrane
Approved $210,000 Paid $35,000

Ronald Taussig, Ph.D.
University of Michigan Medical School
Genetic analysis of mammalian adenylyl cyclase isoforms
Paid $65,000

Wilfred A. van der Donk, Ph.D.
University of Illinois at Urbana-Champaign
Exploring the post-translational modifications of lantibiotics
Paid $65,000

Beverly R. Wendland, Ph.D.
Johns Hopkins University
New pathways to the cell interior: dominant negative and positive effectors of endocytosis
Approved $210,000 Paid $35,000

Toxicological Sciences

Qin M. Chen, Ph.D.
University of Arizona College of Medicine
Tumor suppressor mediated oxidative stress responses
Paid $65,000

Karlene A. Cimprich, Ph.D.
Stanford University School of Medicine
Exploring DNA damage checkpoints using a cell-free system
Approved $210,000 Paid $35,000

Philip A. Cole, M.D., Ph.D.*
Johns Hopkins University School of Medicine
Chemical cross-linking agents for identification of substrates for protein kinases
Approved $130,000 Paid $32,500
Rockefeller University
Paid $32,500

Hilary A. Godwin, Ph.D.
Northwestern University
Biophysical approaches to lead toxicology: biochemistry, detection, and chelation of Pb(II)
Paid $65,000

Jeffrey A. Johnson, Ph.D.*
University of Wisconsin-Madison
Brain glutathione s-transferases and NAD(P)H: quinone oxidoreductase: a role in preventing neurotoxicity
Approved $65,000 Paid $32,500
University of Kansas Medical Center
Paid $32,500

Fang Liu, Ph.D.
Rutgers, the State University of New Jersey College of Pharmacy
Role of TGF-ß-inducible gene regulation in tumorigenesis
Approved $210,000 Paid $35,000

Thomas W. Muir, Ph.D.
Rockefeller University
Structure-activity analysis of the autoinducing peptides from *Staphylococcus aureus* responsible for virulence
Approved $210,000 Paid $35,000

Yoichi Osawa, Ph.D.
University of Michigan Medical School
Chemical approaches to toxicology
Paid $65,000

Jennifer A. Pietenpol, Ph.D.
Vanderbilt University Medical Center
Mechanism of cell cycle checkpoints following genotoxic stress
Paid $65,000

Tomas A. Prolla, Ph.D.
University of Wisconsin Medical School
Genetic characterization of the DNA mismatch repair system in induced mutagenesis
Approved $210,000 Paid $35,000

Zhigang Wang, Ph.D.
University of Kentucky
Mechanism of DNA damage-induced mutagenesis in humans
Paid $65,000

Zhengui Xia, Ph.D.
University of Washington School of Public Health and Community Medicine
Mechanisms of arsenite neurotoxicity
Approved $210,000 Paid $35,000

E. Lynn Zechiedrich, Ph.D.
Baylor College of Medicine
DNA repair and topoisomerases
Paid $65,000

SUBTOTALS: Approved $2,505,000 Paid $1,840,000

Other Grants

Scholar Awards in Experimental Therapeutics

This program has been superseded by the Clinical Scientist Awards in Translational Research.

Arturo Casadevall, M.D., Ph.D.
Albert Einstein College of Medicine
Development of novel antibody-based drugs against bacterial and fungal pathogens
Paid $80,000

Elazer R. Edelman, M.D., Ph.D.
Harvard Medical School
Continuous perivascular drug delivery
Paid $60,000

Jonathan D. Gitlin, M.D.
Washington University School of Medicine
Mechanisms of cellular copper homeostasis
Paid $80,000

Daniel L. Kaufman, Ph.D.
University of California-Los Angeles School of Medicine
Biopharmaceuticals for the prevention of insulin-dependent diabetes mellitus
Paid $80,000

Alan M. Krensky, M.D.
Stanford University School of Medicine
HLA-derived peptides as novel immunosuppressives
Paid $60,000

Thomas Michel, M.D., Ph.D.
Harvard Medical School
Nitric oxide synthases and vascular signal transduction
Paid $80,000

Drew M. Pardoll, M.D., Ph.D.
Johns Hopkins University School of Medicine
Molecular engineering of the antitumor immune response
Paid $80,000

Theresa A. Shapiro, M.D., Ph.D.
Johns Hopkins University School of Medicine
Development of new antiparasitic chemotherapy
Paid $60,000

Steven E. Shoelson, M.D., Ph.D.
Harvard Medical School
Targeting SH2 domains in tyrosine kinase signaling
Paid $80,000

Scholar Awards in Toxicology

This program has been superseded by the New Investigator Awards in the Pharmacological or Toxicological Sciences.

Kim Boekelheide, M.D., Ph.D.
Brown University School of Medicine
The role of cytoskeletal perturbation in testicular injury
Paid $60,000

Christopher Bradfield, Ph.D.
University of Wisconsin-Madison
Molecular genetic approaches to study dioxin toxicology
Paid $80,000

Titia de Lange, Ph.D.
Rockefeller University
Cell-based assays for telomerase toxicity
Paid $80,000

Ellen Li, M.D., Ph.D.
Washington University School of Medicine
Retinoic acid binding proteins and retinoid toxicity
Paid $80,000

Curtis J. Omiecinski, Ph.D.
University of Washington School of Public Health and Community Medicine
Molecular biological approaches to toxicology
Paid $80,000

Dennis J. Thiele, Ph.D.
University of Michigan Medical School
Molecular mechanisms of metal detoxification
Paid $60,000

Bennett Van Houten, Ph.D.
University of Texas Medical Branch-Galveston
Gene-specific repair studies in mice and humans
Paid $60,000

Environment for Science

In addition to our competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Translational Research

American Federation for Medical Research
Support for a meeting titled "Multidisciplinary Translational Research"
Approved $17,225 Paid $17,225

Association for Patient-Oriented Research
Support for the association's first annual meeting
Approved $30,000 Paid $30,000

Association of American Medical Colleges
Support for postdoctoral fellows to participate at the association's Group on Graduate Research, Education, and Training (GREAT) annual conference
Approved $15,000 Paid $15,000

Association of American Physicians
Support for a joint meeting of the association and the American Society for Clinical Investigation
Approved $5,000 Paid $5,000

Pharmacological or Toxicological Sciences

AMC Cancer Research Center
Support for a conference titled "Gene Environment Interactions: Emerging Issues, Technologies, and Biological Paradigms"
Paid $1,000

American Foundation for Pharmaceutical Education
Support for the New Investigators Program for Pharmacy Faculty
Paid $468,000

American Society for Microbiology
Support for a meeting titled "DNA Repair and Mutagenesis: Mechanism, Control, and Biological Consequences"
Approved $5,000 Paid $5,000

American Society for Pharmacology and Experimental Therapeutics
Support for a symposium and the Burroughs Wellcome Fund Lecture at the society's national meeting
Paid $8,700

Aspen Cancer Conference Inc.
Support for a conference titled "Mechanisms of Toxicity and Carcinogenesis"
Approved $2,500 Paid $2,500

Canadian Society for Pharmaceutical Sciences
Support for an international symposium titled "Exploring Human Diversity in Drug Development and Pharmacotherapy"
Approved $1,500 Paid $1,500

Gordon Research Conferences
Support for the Conference on Mammalian DNA Repair
Approved $7,500 Paid $7,500

Gordon Research Conferences
Support for the Genetic Toxicology Conference
Approved $25,000 Paid $25,000

Neurobehavioral Teratology Society
Support for the society's annual meeting
Approved $1,000 Paid $1,000

Society of Toxicology
Support for graduate students to participate at the society's annual meeting
Approved $10,000 Paid $10,000

Teratology Society
Support for graduate students and postdoctoral fellows to participate at the society's annual meeting
Approved $5,000 Paid $5,000

University of Michigan Medical School
Support for a conference titled "New Directions in Pharmacogenetics and Ecogenetics"
Approved $5,000 Paid $5,000

SUBTOTALS: Approved $129,725 Paid $1,767,425

TOTAL APPROVED $1,655,500 TOTAL PAID $690,750

Career Awards in the Biomedical Sciences

These awards targeted at reproductive sciences are made through the Career Awards in the Biomedical Sciences program; the majority of the career awards are listed under the "Career Development of Scientists" section of the Grants Index.

** Career awards are postdoctoral-faculty bridging awards, and many recipients change institutions upon obtaining a faculty position. For these awardees, indicated with an asterisk, BWF cancels the original grant to the postdoctoral institution and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the faculty-level grants are listed first and the canceled grants are listed second.*

David E. Cummings, M.D.
University of Washington School of Medicine
Studies of spermatogenesis and metabolism using mutant mice
Paid $29,150

William L. Kraus, Ph.D.
Cornell University
Biochemical analysis of estrogen receptor activity with chromatin templates
Approved $357,500 Paid $121,000

Bruce T. Lahn, Ph.D.*
University of Chicago
Systematic investigation of mammalian spermatogenesis
Approved $386,000
Massachusetts Institute of Technology
Approved $508,000

Mala S. Mahendroo, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Characterization of fecundity and parturition defects in mice deficient in steroid 5 alpha-reductase type 1
Paid $29,150

Kelle H. Moley, M.D.
Washington University School of Medicine
Glucose transport and apoptosis in blastocysts from diabetic mice
Paid $27,500

Carmen J. Williams, M.D., Ph.D.
University of Pennsylvania School of Medicine
Signal transduction mechanisms during mouse egg activation
Paid $59,950

SUBTOTALS: Approved $1,251,500 Paid $266,750

Obstetrics and Gynecology Research Fellowships

Henry L. Galan, M.D. (1997-2000)
University of Colorado Health Sciences Center
Role of endothelial nitric oxide in the fetal placental unit in an experimental model of intrauterine growth restriction
Paid $48,000

Karen H. Lu, M.D. (1999-2002)
Harvard Medical School
Genetic alterations in ovarian cancers associated with germ line *BRCA1* mutations
Approved $144,000 Paid $48,000

Douglas A. Woelkers, M.D. (1998-2001)
University of Pittsburgh School of Medicine
Oxidative stress and preeclampsia
Paid $48,000

SUBTOTALS: Approved $144,000 Paid $144,000

Reproductive Scientist Development Program Research Grants

Carolyn Y. Muller, M.D.
University of Texas Southwestern Medical Center-Dallas
Prospective determination of genetic alterations in cervical preneoplasia with correlation to risk exposure and behavior
Paid $80,000

Salli I. Tazuke, M.D.
Stanford University Medical Center
Molecular analysis of early germ cell overgrowth and its function in germ line stem cell biology
Approved $240,000   Paid $80,000

SUBTOTALS: Approved $240,000   Paid $160,000

Other Grants

Environment for Science

In addition to our competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Endocrine Society
Support for the society's postdoctoral fellows to participate at its annual meeting
Approved $6,000   Paid $6,000

Marine Biological Laboratory
Support for the training course Frontiers in Reproduction
Approved $6,500   Paid $106,500

Society for the Study of Reproduction
Support for the society's postdoctoral fellows to participate at its annual meeting
Approved $7,500   Paid $7,500

SUBTOTALS: Approved $20,000   Paid $120,000

TOTAL APPROVED $5,169,446 TOTAL PAID $2,426,115

Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences

Brain Science Interfaces Program
Brown University
John P. Donoghue, Ph.D.
David Mumford, Ph.D.
Approved $2,304,760 Paid $345,714

Interdisciplinary Graduate and Postdoctoral Training Program in Physics, Chemistry, and Biology
Rockefeller University
Stephen K. Burley, M.D., D.Phil.
Albert Libchaber, Ph.D.
Paid $393,750

La Jolla Interfaces in Science Program
Consortium of the University of California-San Diego, the Scripps Research Institute, the Salk Institute for Biological Studies, and the San Diego Supercomputing Center; grant administered by the University of California-San Diego
Elizabeth D. Getzoff, Ph.D.
Scripps Research Institute
José N. Onuchic, Ph.D.
University of California-San Diego
Paid $383,765

Program in Computational Biology
Johns Hopkins University and the Institute for Genomic Research
Michael Paulaitis, Ph.D.
Johns Hopkins University
George D. Rose, Ph.D.
Johns Hopkins University School of Medicine
Approved $2,500,000 Paid $375,000

Program in Computational Molecular Biology
California Institute of Technology
Scott E. Fraser, Ph.D.
Michael L. Roukes, Ph.D.
Paid $375,000

Program in Mathematics and Molecular Biology
Consortium of 17 laboratories at 12 institutions nationwide: grant administered by Florida State University
Wilma K. Olson, Ph.D.
Rutgers, the State University of New Jersey
DeWitt L. Sumners, Ph.D.
Florida State University
Paid $375,000

SUBTOTALS: Approved $4,804,760 Paid $2,248,229

Other Grants

Environment for Science

In addition to our competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

American Physiological Society
Support for the Physiology InFocus Program on Physiological Genomics, held at the Experimental Biology '99 meeting
Approved $10,000 Paid $10,000

Canadian Genetic Diseases Network
Support for computer-laboratory based workshops in bioinformatics
Approved $62,000 Paid $62,000

Cold Spring Harbor Laboratory
Support for developing a course on genome informatics
Approved $25,000 Paid $25,000

Florida State University
Support for a workshop titled "Doing Science at the Interface," held at the University of California-Berkeley
Approved $10,886 Paid $10,886

University of California-San Diego
Support for a workshop and symposium titled "Quantitative Challenges in the Post-Genomic Sequence Era"
Approved $256,800 Paid $70,000

SUBTOTALS: Approved $364,686 Paid $177,886

TOTAL APPROVED $2,808,409 TOTAL PAID $2,011,306

Student Science Enrichment Program

American Chemical Society, North Carolina Local Section
Summer Educational Experience for the Disadvantaged
Paid $59,310

American Heart Association, North Carolina Council
High School Student Research Program
Paid $20,000

Bennett College
Mathematics, Science, Engineering, and Technology Scholars Program
Approved $180,000 Paid $60,000

Campbell University School of Pharmacy
Harnett Central Middle School Science and Technology Enrichment Program
Paid $40,300

Catawba Science Center Inc.
Circle of Support
Paid $43,709

Charlotte Area Health Education Center
Shadow Hands—Minority Workforce Development Project
Approved $15,000 Paid $15,000

Cumberland County Schools
Cape Fear Natural Science Academy
Approved $180,000 Paid $60,000

Durham Academy
Durham Public Schools Summer Institute
Approved $180,000 Paid $60,000

Durham Public Schools
Bridging Education Science and Technology High School Molecular Research Preparation Course
Paid $51,685

Mountain Area Gardens in Community Inc.
Middle School Apprenticeship Program in Garden-Related Sciences
Approved $81,210 Paid $32,404

North Carolina Aquarium on Roanoke Island
A Mentor-Learner Approach to Science Enrichment
Paid $59,837

North Carolina Museum of Life and Science
Museums and Universities for Science Enrichment of Students
Approved $173,232 Paid $53,774

North Carolina State Museum of Natural Science
Girls in Science Statewide Project
Approved $164,202 Paid $54,227

North Carolina State University
Science and Mathematics Colloquies at the Science House
Paid $44,514

Pines of Carolina Girl Scout Council Inc.
Science and Technology around Research Triangle Park
Paid $59,800

Roanoke Rapids City Schools
Summer Science Explorations in the Roanoke Valley
Approved $60,000 Paid $20,000

Science Museums of Wilson: Imagination Station
Minorities' Interest Nurtured and Developed in Science Student Scientist Program
Paid $42,349

Shodor Education Foundation Inc.
Stimulating Understanding of Computational Science through Collaboration, Exploration, Experiment, and Discovery
Paid $59,830

Southeastern Community College
Explorations in Science
Paid $28,982

University of North Carolina-Chapel Hill
Adventures in Biomolecular Sciences
Paid $50,040

University of North Carolina-Chapel Hill School of Medicine
Research Apprenticeship Program
Paid $59,890

University of North Carolina-Wilmington
Cape Fear Science Camp
Paid $40,030

University of North Carolina-Wilmington
Oceanographic Field Support for Summer Ventures in Science and Mathematics
Approved $30,375 Paid $10,125

Wake Forest University School of Medicine
Linking Career Choices to Student Experiences: Mini-Fellowships in Science Fields
Paid $59,460

Warren Wilson College
Environmental Science Camp
Approved $146,250

SUBTOTALS: Approved $1,210,269 Paid $1,085,266

BWF Visiting Professorships in the Basic Medical Sciences

Listed by host institution, visiting professor, and professor's affiliation. Titles of BWF Lectures cited if given in fiscal year 1999.

Allegheny University of the Health Sciences
E. Richard Moxon, M.D., B.Chir.
University of Oxford (United Kingdom)
The challenge of the *Meningococcus*
Paid $5,000

Case Western Reserve University School of Medicine
Robert M. Graham, M.D.
University of New South Wales (Australia)
Approved $5,000

Dalhousie University Faculty of Medicine
Harold L. Atwood, Ph.D., D.Sc.
University of Toronto
Approved $5,000

Duke University Medical Center
Jerry W. Shay, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Molecular mechanisms regulating human cellular aging
Paid $5,000

East Carolina University School of Medicine
Isaiah I. Fidler, D.V.M., Ph.D.
University of Texas M. D. Anderson Cancer Center
Approved $5,000

Emory University School of Medicine
Jeffrey I. Gordon, M.D.
Washington University School of Medicine
Eavesdropping on interactions between the gut microflora and epithelium, and Exploring the mechanism and significance of protein N-myristoylation
Paid $5,000

Emory University School of Medicine
Jean-Philippe Pin, Ph.D.
National Center for Scientific Research (France)
Approved $5,000

Idaho State University College of Pharmacy
Gerald L. Dohm, Ph.D.
East Carolina University School of Medicine
Approved $5,000

Indiana University School of Medicine
Piers E. Emson, Ph.D.
Babraham Institute (United Kingdom)
Approved $5,000

Iowa State University
Simin Meydani, D.V.M., Ph.D.
Tufts University
Nutrition and immune function
Paid $5,000

Kansas State University
Claude E. Klee, M.D.
National Cancer Institute
Calcineurin: coupling between oxidative stress and calcium signaling
Paid $5,000

Louisiana State University Health Sciences Center
Stephen F. Heinemann, Ph.D.
Salk Institute for Biological Studies
Approved $5,000

Louisiana State University School of Medicine-New Orleans
Louis J. Ignarro, Ph.D.
University of California-Los Angeles School of Medicine
Physiological and pathophysiological roles of nitric oxide
Paid $5,000

Medical College of Ohio
Richard J. Roberts, Ph.D.
New England BioLabs
Approved $5,000

Medical College of Wisconsin
Robert Unwin, Ph.D.
University College London Medical School (United Kingdom)
Kidney stones, red cells, and urine pH
Paid $5,000

Medical University of South Carolina College of Medicine
Ivan Diamond, M.D., Ph.D.
University of California-San Francisco School of Medicine
Approved $5,000

Meharry Medical College
Oliver Smithies, D.Phil.
University of North Carolina-Chapel Hill School of Medicine
Essential hypertension: a genetic disease due to many little things
Paid $5,000

Memorial University of Newfoundland Faculty of Medicine
Mary-Claire King, Ph.D.
University of Washington
A genetic analysis of breast cancer
Paid $5,000

North Dakota State University
William H. Dietz, M.D., Ph.D.
Centers for Disease Control and Prevention
Therapeutic treatment of childhood obesity
Paid $5,000

Northeastern Ohio Universities College of Medicine
Donald M. McDonald, M.D., Ph.D.
University of California-San Francisco School of Medicine
Mechanism of plasma leakage in neurogenic inflammation
Paid $5,000

Ohio State University
Sidney Altman, Ph.D.
Yale University
Approved $5,000

Pennsylvania State University
Chung S. Yang, Ph.D.
Rutgers, the State University of New Jersey-Piscataway
Dietary strategies for the reduction of cancer risk
Paid $5,000

Rush-Presbyterian-Saint Luke's Medical Center
Peter C. Bruckner, Ph.D.
University of Muenster (Germany)
Approved $5,000

Saint Louis University School of Medicine
Steve Smale, Ph.D.
University of California-Los Angeles School of Medicine
Approved $5,000

San Juan Bautista School of Medicine
Emil Skamene, M.D.
McGill University
Genetic control of susceptibility to tuberculosis and leprosy
Paid $5,000

State University of New York Health Science Center-Syracuse
Winfield S. Sale, Ph.D.
Emory University School of Medicine
Approved $5,000

Thomas Jefferson University Jefferson Medical College
Jennifer Lippincott-Schwartz, Ph.D.
National Institute of Child Health and Human Development
Unraveling membrane trafficking pathways with green fluorescent protein
Paid $5,000

Tulane University School of Medicine
Emil R. Unanue, M.D.
Washington University School of Medicine
Approved $5,000

Tulane University School of Medicine
Pierre Corvol, M.D.
College of France
Genetics of human hypertension
Paid $5,000

University of Arizona
Eric R. Kandel, M.D.
Columbia University College of Physicians and Surgeons
Approved $5,000

University of Arizona College of Medicine
W. James Nelson, Ph.D.
Stanford University Medical Center
Cues for cellular asymmetry in polarized epithelia
Paid $5,000

University of British Columbia Faculty of Medicine
Thomas G. Spiro, Ph.D.
Princeton University
Approved $5,000

University of California-Berkeley
Luigi M. De Luca, Ph.D.
National Cancer Institute
Multistage carcinogenesis as the background for intervention strategies: the experience with retinoic acid
Paid $5,000

University of California-Santa Barbara
James E. Darnell Jr., M.D.
Rockefeller University
Approved $5,000

University of Colorado-Boulder
Paul Nurse, Ph.D.
Imperial Cancer Research Fund (United Kingdom)
How cells grow in a straight line
Paid $5,000

University of Georgia
David A. York, Ph.D.
Pennington Biomedical Research Center
Approved $5,000

University of Guelph
Karlheinz Altendorf, Ph.D.
University of Osnabruck (Germany)
The osmosensory mechanism of sensor kinase KdpD of *Escherichia coli*
Paid $5,000

University of Illinois at Urbana-Champaign
Richard L. Atkinson Jr., M.D.
University of Wisconsin-Madison
Approved $5,000

University of Illinois-Chicago
Richard W. Tsien, D.Phil.
Stanford University School of Medicine
Approved $5,000

University of Louisville School of Medicine
Bruce Demple, Ph.D.
Harvard School of Public Health
Approved $5,000

University of Manitoba Faculty of Medicine
Stephen E. Epstein, M.D.
Washington Hospital Center
The role of infection in atherosclerosis
Paid $5,000

University of Medicine and Dentistry of New Jersey
Bengt Samuelsson, M.D.
Karolinska Institute (Sweden)
Approved $5,000

University of Miami School of Medicine
Michael J. Bevan, Ph.D.
University of Washington
Approved $5,000

University of Michigan Medical School
Hans-Jochem Kolb, M.D., Ph.D.
University of Munich (Germany)
Approved $5,000

University of Mississippi Medical Center
William Lederer, M.D., Ph.D.
University of Maryland School of Medicine
Approved $5,000

University of North Carolina-Chapel Hill School of Medicine
Alan Hall, Ph.D.
University College London (United Kingdom)
Approved $5,000

University of North Carolina-Greensboro
Cheryl Achterberg, Ph.D.
Pennsylvania State University
When pills become food and food becomes pills: dietary patterns among older adults
Paid $5,000

University of Northern Iowa
Thomas A. Pressley, Ph.D.
Texas Tech University Health Sciences Center
The Na, K-pump: regulation and diversity in the maintenance of cellular homeostasis
Paid $5,000

University of Oklahoma Health Sciences Center
James Hill, Ph.D.
Louisiana State University Eye Center
Herpes viruses: genomic factors and unique pharmacological receptors involved in latency and reactivation
Paid $5,000

University of Pittsburgh School of Medicine
Alfred Singer, M.D.
National Cancer Institute
Signals driving T lymphocyte development in the thymus
Paid $5,000

University of Saskatchewan College of Medicine
Paul Talalay, M.D.
Johns Hopkins University School of Medicine
Approved $5,000

University of Tennessee-Memphis College of Medicine
David E. Clapham, M.D., Ph.D.
Harvard Medical School
Intracellular calcium signaling
Paid $5,000

University of Texas-Austin College of Pharmacy
Gerald M. Cohen, Ph.D.
University of Leicester (United Kingdom)
Approved $5,000

University of Texas Health Science Center-San Antonio
Howard K. Schachman, Ph.D.
University of California-Berkeley
Approved $5,000

University of the Central Caribbean School of Medicine
George P. Hess, Ph.D.
Cornell University
Kinetic investigation of cell surface receptors in the microseconds-to-milliseconds time region
Paid $5,000

University of Toronto
Charles S. Lieber, M.D.
Veterans Affairs Medical Center-Bronx
Metabolism and toxicology of ethanol, including interactions with other drugs
Approved $5,000 Paid $5,000

University of Vermont College of Medicine
Johan P. Stenflo, M.D., Ph.D.
Lund University (Sweden)
Vitamin K-dependent clotting factors and related proteins
Paid $5,000

University of Washington School of Medicine
Solomon H. Snyder, M.D.
Johns Hopkins University School of Medicine
Novel neural messages
Paid $5,000

University of Western Ontario Faculty of Medicine and Dentistry
Victor J. Dzau, M.D.
Harvard Medical School
Approved $5,000

Wake Forest University School of Medicine
Michael E. Greenberg, Ph.D.
Harvard Medical School
Approved $5,000

Washington State University College of Veterinary Medicine
Harris A. Lewin, Ph.D.
University of Illinois at Urbana-Champaign
Approved $5,000

West Virginia University School of Medicine
George J. Augustine, Ph.D.
Duke University Medical Center
Molecular mechanisms of neurotransmitter secretion
Paid $5,000

Wright State University School of Medicine
Peter Arvan, M.D., Ph.D.
Albert Einstein College of Medicine
Molecular chaperones that regulate export of secretory proteins from the endoplasmic reticulum: an important role in thyroid disease
Paid $5,000

Yale University School of Medicine
Stephen J. Benkovic, Ph.D.
Pennsylvania State University
DNA replication carried out by bacteriophage T_4 DNA replication machinery
Paid $5,000

York University
Michael W. Gray, Ph.D.
Dalhousie University Faculty of Medicine
New twists on old paradigms of mitochondrial evolution
Paid $5,000

SUBTOTALS: Approved $165,000 Paid $165,000

BWF Visiting Professorships in the Microbiological Sciences

Listed by host institution, visiting professor, and professor's affiliation. Titles of BWF Lectures cited if given in fiscal year 1999.

Arkansas Tech University
Michael S. DuBow, Ph.D.
McGill University
Approved $5,000

California State University-Fullerton
James D. Oliver, Ph.D.
University of North Carolina-Charlotte
Approved $5,000

Lehigh University
Susan R. Ross, Ph.D.
University of Pennsylvania School of Medicine
Mouse models of disease
Paid $5,000

Louisiana State University
Tlahun D. Yilma, D.V.M., Ph.D.
University of California-Davis School of Veterinary Medicine
Global eradication of rindpest: technology transfer in molecular biology to developing countries
Paid $5,000

McGill University
Robert Kadner, Ph.D.
University of Virginia School of Medicine
Approved $5,000

Meharry Medical College
Francis L. Macrina, Ph.D.
Virginia Commonwealth University School of Medicine
Streptococcal endocarditis: pathogenesis and vaccine development
Paid $5,000

North Carolina State University
Claire M. Fraser, Ph.D.
Institute for Genomic Research
Approved $5,000

Oakland University
Thomas J. Silhavy, Ph.D.
Princeton University
Parallel pathways perceive periplasmic problems
Paid $5,000

Prairie View A&M University
Debra Murray, Ph.D.
Veterans Administration Medical Center-Dallas
Approved $5,000

University of Alberta Faculty of Medicine and Oral Health Sciences
Barry J. Marshall, M.D.
University of Virginia Health Sciences Center
Helicobacter pylori: past, present, and future
Paid $5,000

University of Arkansas-Monticello
John Iandolo, Ph.D.
University of Oklahoma Health Sciences Center
Approved $5,000

University of Dayton
Barbara H. Iglewski, Ph.D.
University of Rochester School of Medicine and Dentistry
Cell-cell communication among bacteria
Paid $5,000

University of Florida
Kenneth E. Rudd, Ph.D.
University of Miami School of Medicine
Microbial genome sequences: gold mines or land mines?
Paid $5,000

University of Guam
Hans W. Paerl, Ph.D.
University of North Carolina-Chapel Hill
Approved $5,000

University of Kentucky School of Medicine
Andrew D. Steele, Ph.D.
Medical University of Southern Africa (South Africa)
Approved $5,000

University of Massachusetts Medical Center
Jorge E. Galan, D.V.M., Ph.D.
Yale University School of Medicine
Approved $5,000

University of New Mexico School of Medicine
Michael J. Buchmeier, Ph.D.
Scripps Research Institute
Approved $5,000

University of Puerto Rico School of Medicine
Jay A. Levy, M.D.
University of California-San Francisco School of Medicine
Host immune response can prevent HIV infection and disease progression
Paid $5,000

University of Texas Health Science Center-San Antonio
John J. Mekalanos, Ph.D.
Harvard Medical School
Genetic elements and their role in emergence of bacterial pathogens
Paid $5,000

University of Wisconsin-Madison
Rudolf K. Thauer, Ph.D.
University of Marburg (Germany)
Approved $5,000

Virginia Union University
Clifford Houston, Ph.D.
University of Texas Medical Branch-Galveston
The significance of microbiology as a career option as we approach the 21st century
Paid $5,000

SUBTOTALS: Approved $55,000 Paid $50,000

Other Grants

Environment for Science

In addition to our competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Alzheimer's Association
Support in lieu of an honorarium for Elmima Johnson, Ph.D., member of BWF Science Education Advisory Committee
Approved $1,250 Paid $1,250

American Heart Association
Support in lieu of an honorarium for Elmima Johnson, Ph.D., member of BWF Science Education Advisory Committee
Approved $1,250 Paid $1,250

American Society for Microbiology
Support for administration of the 1999-2000 BWF Visiting Professorships in the Microbiological Sciences
Approved $2,500

Canadian Federation of Biological Societies
Support for administration of the 1999-2000 BWF Visiting Professorships in the Basic Medical Sciences
Approved $2,500 Paid $2,500

Federation of American Societies for Experimental Biology
Support for administration of the 1999-2000 BWF Visiting Professorships in the Basic Medical Sciences
Approved $9,600

Grantmakers for Education
Support for general activities
Approved $1,000 Paid $1,000

Medical Research Council of Canada
Support for the Burroughs Wellcome Fund Student Research Awards
Paid $500,000

National Academy of Sciences
Support for a workshop to assess issues and opportunities for Ph.D. scientists who are interested in becoming high school teachers
Approved $200,000

North Carolina Association for Biomedical Research
Support for general activities
Approved $25,000 Paid $25,000

North Carolina Museum of Life and Science
Support for a science education initiative
Approved $1,000,000

North Carolina Science Olympiad
Support for the 1999-2000 tournament
Approved $5,000

North Carolina State University
Support for a conference of representatives from university science departments to discuss K-12 outreach
Approved $63,180 Paid $63,180

Public School Forum of North Carolina
Support for the Institute for Educational Policymakers
Paid $50,000

Public School Forum of North Carolina
Support for a study of the impact of a decade of British experimentation with school choice
Approved $46,860 Paid $46,860

Sigma Xi, the Scientific Research Society
Support for the society's annual forum, titled "Reshaping Undergraduate Science and Engineering Education: Tools for Better Learning"
Approved $20,000 Paid $20,000

SUBTOTALS: Approved $1,378,140 Paid $711,040

TOTAL APPROVED $1,392,100 TOTAL PAID $932,970

Additional grants made through this program are listed in the previous sections under "Other Grants."

General

American Association for the Advancement of Science
Support for the Center for Science, Technology, and Congress
Approved $300,000 Paid $100,000

American Association for the Advancement of Science
Support for a workshop titled "How to Fund Science: the Future of Medical Research"
Paid $70,350

American Enterprise Institute for Public Policy Research
Support for research activities on biomedical policy
Approved $5,000 Paid $5,000

American Heart Association, North Carolina Council
Support for general activities
Approved $1,000 Paid $1,000

Arthritis Foundation
Support for the Lifetime Achievement Award Dinner honoring the late Gertrude B. Elion, D.Sc., BWF board member
Approved $5,000 Paid $5,000

Center for the Advancement of Health
Support for an initiative to build scientific capacity for conducting behavioral research and for translating research into policy and practice
Approved $100,000

Commission on Professionals in Science and Technology
Support for general activities
Approved $5,000 Paid $5,000

Council on Foundations
Support for general activities
Approved $39,600 Paid $39,600

Duke University School of Medicine
Support for general activities of Duke Children's Hospital
Approved $5,500 Paid $5,500

Foundation Center
Support for general activities and for a database redesign project
Approved $10,000 Paid $10,000

George Washington University
Support for a program titled "Medical Knowledge and Technology Development and Diffusion," conducted by the National Health Policy Forum
Approved $100,000 Paid $100,000

Grantmakers in Health
Support for general activities
Approved $5,000 Paid $5,000

Harvard Medical School
Support for a study of the prevalence of substance abuse among college undergraduates
Approved $4,750 Paid $4,750

Institute for Science Philanthropy
Support for starting the institute
Approved $40,000 Paid $40,000

Institute of Medicine
Support for general activities
Approved $5,000 Paid $5,000

Johns Hopkins University School of Medicine
Support for the Daniel Nathans Lectureship in the Basic Medical Sciences
Approved $20,000 Paid $20,000

Medical Research Council of Canada
Support for establishing a 21st century health sciences research institute system
Paid $150,000

Museum of Science-Boston
Support for general activities
Approved $10,000 Paid $10,000

National Library of Medicine
Support for general activities
Approved $5,000 Paid $5,000

North Carolina Center for Nonprofits
Support for general activities
Approved $1,000 Paid $1,000

North Carolina Central University
Support for a conference titled "Increasing the Representation of Minorities in Biotechnology Careers"
Approved $2,500 Paid $2,500

North Carolina Central University
Support for developing environmental toxicology research and training programs
Approved $50,000 Paid $50,000

North Carolina State University
Support for the Jerry and Adela Whitten College Scholars Endowment, a merit scholarship for undergraduate students in the physical and mathematical sciences
Approved $15,000 Paid $15,000

Research!America
Support for continuation of 435 Project to increase funding for medical research
Approved $25,000 Paid $25,000

Society for the Advancement of Women's Health Research
Support for general activities
Approved $5,000 Paid $5,000

Southeastern Council of Foundations
Support for general activities
Approved $5,000 Paid $5,000

Triangle Community Foundation
Support for the Gertrude B. Elion Fund, named in honor of the late BWF board member
Approved $500,000

University of North Carolina-Chapel Hill School of Medicine
Support for a joint conference room and boardroom named in honor of Joseph Pagano, M.D., BWF board member, at the Lineberger Comprehensive Cancer Center
Paid $20,000

Washington University School of Medicine
Support for the David M. Kipnis Lectureship and for the David M. Kipnis Award for Ph.D. or M.D.-Ph.D. students for meritorious research
Approved $20,000 Paid $20,000

SUBTOTALS: Approved $1,284,350 Paid $724,700

Communications

American Association for the Advancement of Science
Support for EurekAlert!
Paid $60,000

American Association for the Advancement of Science
Support for the Mass Media Science and Engineering Fellows Program
Approved $16,000 Paid $16,000

Council for the Advancement of Science Writing
Support for the New Horizons in Science Briefing
Approved $20,000 Paid $20,000

Sigma Xi, the Scientific Research Society
Support for producing a documentary on the late Gertrude B. Elion, D.Sc., BWF board member
Approved $42,750 Paid $42,750

SUBTOTALS: Approved $78,750 Paid $138,750

History of Medicine

Association of Military Surgeons of the United States
Support for the Sir Henry Wellcome Medal and Prize
Approved $10,000 Paid $6,833

New York Academy of Medicine
Support for the Burroughs Wellcome Fund Retrospective on Medical Science in the 20th Century
Approved $13,000 Paid $13,000

SUBTOTALS: Approved $23,000 Paid $19,833

Inactive Programs—Active Awardees of Former Programs

Fellowships in Sexually Transmitted Diseases

These awards are administered in partnership with the American Social Health Association. BWF awards the primary grant to the association, which distributes the funds to the individual awardees.

Sanjay Ram, M.D.
Boston University School of Medicine
Interaction between *Neisseria gonorrhoeae* porin and complement down-regulators: a model for gonococcal pathogenesis
Paid $30,937

Hitchings-Elion Trust Fellowships

These awards were made jointly by BWF and the Wellcome Trust, BWF's sister philanthropy in the United Kingdom.

James McDonnell, Ph.D.
Rockefeller University
Biophysical characterization of IgE network interaction
Approved $3,000

Peter E. Warburton, Ph.D.
Mount Sinai School of Medicine
Chromosomal replication control in transfected YACS
Approved $3,000 Paid $3,000

New Investigator Awards in Virology

These awards are administered in partnership with the Infectious Diseases Society of America. BWF awards the primary grant to the society, which distributes the funds to the individual awardees.

Jeffrey L. Meier, M.D.
University of Iowa College of Medicine
Mechanisms governing human cytomegalovirus latency
Paid $15,750

SUBTOTALS: Approved $6,000 Paid $49,687

INFORMATION FOR APPLICANTS

The Burroughs Wellcome Fund makes approximately 90 percent of our grants through competitive award programs, which support investigators in targeted areas of basic scientific research that have relevance to human health. All but one of our award programs are open to scientists who are citizens or permanent residents of the United States and Canada. (The program that is open only to U.S. scientists is noted in the program descriptions that follow.) Awards are made with the advice of BWF's advisory committees, which are composed of scientists and educators selected for their expertise in the program areas. Program application deadlines for the 2001 award series are listed in the "Program Application Deadlines" section.

BWF believes that diversity within the scientific community enhances the well-being of the research enterprise; therefore, we encourage applications from women and from members of underrepresented minority groups.

Most awards are made only to degree-granting institutions on behalf of individual researchers, who must be nominated by their institution. Institutions receiving awards must be tax-exempt 501(c)(3) organizations. Government agencies, such as the National Institutes of Health and the Centers for Disease Control and Prevention, generally are not eligible for awards.

BWF does not support activities that are primarily clinical in nature (such as disease diagnosis and treatment) or primarily related to health care and health care policy. We generally do not provide support for research projects or other activities outside our competitive programs, nor do we generally support endowments, development campaigns, ordinary operating expenses, capital facilities and equipment, or publications.

To obtain information about programs

Burroughs Wellcome Fund
21 T. W. Alexander Drive
Post Office Box 13901
Research Triangle Park, NC 27709
Telephone (919) 991-5100
Fax (919) 991-5160

www.bwfund.org

Career Development of Scientists

Career Awards in the Biomedical Sciences

These awards are made in honor of George H. Hitchings, Ph.D., and Gertrude B. Elion, D.Sc., both of whom were long associated with the Burroughs Wellcome Fund. The awards are intended to foster the development and productivity of biomedical researchers who are early in their careers and to help them make the critical transition to becoming independent investigators. The awards provide support ranging from $445,000 over four years to $574,000 over six years to bridge advanced postdoctoral training and the first three years of faculty service. Recipients may spend part of the award period at institutions in the United Kingdom or the Republic of Ireland. It is anticipated that at least 20 awards will be made annually; awards specifically targeted at reproductive science will be included. Approximately half of the awards will go to researchers with a Ph.D. degree and half to those with an M.D. or M.D.-Ph.D. degree. Candidates must have completed at least 12 months but not more than 48 months of postdoctoral research training by the application deadline. For candidates with M.D. degrees, postdoctoral training excludes clinically oriented residencies that do not contain a major research component. Researchers who hold a faculty appointment as an assistant professor or the equivalent, or who know they will hold such an appointment within a year of the application deadline, are not eligible.

Hitchings-Elion Fellowships

Beginning with the 2001 award series, these awards are merged with BWF's Career Awards in the Biomedical Sciences. The fellowships provided support for postdoctoral scientists to pursue training in the United Kingdom or the Republic of Ireland and then return to a faculty position in the United States or Canada. Postdoctoral researchers interested in such a career path now should apply to the Career Awards in the Biomedical Sciences program.

Life Sciences Research Fellowships

These awards provide $120,000 over three years for postdoctoral scientists pursuing research careers in the life sciences. It is anticipated that three awards will be made annually. These fellowships are administered in partnership with the Life Sciences Research Foundation (LSRF); contact LSRF for information (410/467-2597).

BWF Research Travel Grants

(Including History of Medicine)

These grants enable biomedical scientists and medical historians to work for brief periods—from two weeks to six months—in the United Kingdom or the Republic of Ireland. The grants are intended to facilitate the rapid exchange of knowledge and to promote collaboration among scientists in the countries involved. BWF makes approximately 60 grants annually, including approximately 10 in the history of medicine. Meant to cover travel and living expenses, grants average $6,000 and typically range from $1,500 to $15,000. Three types of travel grants are offered: for established scientific investigators, for medical historians, and for postdoctoral fellows and advanced graduate students. Visiting scientific investigators are required to work in collaboration with a host scientific sponsor, and they may participate in research projects in the basic biomedical sciences, medically oriented behavioral sciences, and clinical research, as well as in training projects to acquire new research techniques. Visiting medical historians may either participate in collaborative research projects with a host sponsor or conduct their own research projects. Established scientific investigators and medical historians must have an M.D. or Ph.D. degree and hold an academic appointment at the assistant professor level or above at a degree-granting institution. Postdoctoral fellows must be early in their careers; graduate students must be within a year of receiving their doctorates.

Emerging Infectious Diseases

Scholar Awards and New Investigator Awards in Molecular Parasitology

These awards are intended to foster the development and productivity of scientists who will bring new ways of thinking and new experimental approaches to the study of parasitic diseases. Scholar awards provide $425,000 over five years ($85,000 per year), and new investigator awards provide $210,000 over three years ($70,000 per year). It is anticipated that two scholar awards and four new investigator awards will be made annually. The awards are intended to give recipients the freedom and flexibility to pursue new avenues of inquiry and higher-risk research projects that hold potential for advancing significantly the biochemical, pharmacological, immunological, and molecular biological knowledge of major pathogens and arthropod vectors that spread parasitic diseases. BWF is interested particularly in supporting investigators who will move modern molecular techniques into the study of parasitic systems, as well as those whose work will extend the study of parasites in new directions. Candidates must have an M.D. or Ph.D. degree. Candidates for scholar awards must have established a record of independent research and hold a tenure-track position as an associate professor or its equivalent. Consideration also will be given to more senior investigators who are either significantly reorienting their research from another field to molecular parasitology or significantly switching research directions within the field. Candidates for new investigator awards must hold a tenure-track position as an assistant professor or its equivalent, and they must have established a record of independent research at the faculty level.

Scholar Awards and New Investigator Awards in Molecular Pathogenic Mycology

These awards are intended to foster the development and productivity of scientists who will bring new ways of thinking and new experimental approaches to the study of disease-causing fungi. Scholar awards provide $425,000 over five years ($85,000 per year), and new investigator awards provide $210,000 over three years ($70,000 per year). It is anticipated that three scholar awards and three new investigator awards will be made annually. The awards are intended to give recipients the freedom and flexibility to pursue new avenues of inquiry and higher-risk research projects that hold potential for advancing significantly the field of medical mycology. BWF is interested particularly in supporting scientists—including investigators already working in mycology as well as those from other fields—who will use modern techniques from molecular biology, biochemistry, immunology, pharmacology, and genetics to advance fundamental knowledge of virulent fungal pathogens. Candidates must have an M.D. or Ph.D. degree. Candidates for scholar awards must have established a record of independent research and hold a tenure-track position as an associate professor or its equivalent. Consideration also will be given to more senior investigators who are significantly reorienting their research from another field to medical mycology. Candidates for new investigator awards must hold a tenure-track position as an assistant professor or its equivalent, and they must have established a record of independent research at the faculty level.

New Initiatives in Malaria Research

These awards are intended to increase the fundamental understanding of the biology and pathogenesis of malaria. Two types of awards are offered. One type, which provides up to $400,000 over four years (up to $100,000 per year), is intended to support studies that bring new ways of thinking and new experimental approaches to malaria research. The second type, which provides $100,000 over two years ($50,000 per year), is intended to support feasibility studies and pilot work that will underpin higher-risk projects in malaria, or to support investigators from other fields who are reorienting their research to malaria. It is anticipated that up to $1.5 million will be spent on awards annually, with the split between four-year awards and two-year awards to be determined during the selection process. The awards are intended to attract more investigators to work on malaria, to encourage them to bring novel approaches to studying the pathogens and the arthropod vectors responsible for causing the disease, and to enhance scientific collaborations among investigators at the same or different institutions. Experience in malaria research is not a prerequisite. BWF seeks to encourage individuals from other fields to apply their expertise in bringing new ideas and approaches to the study of malaria. Candidates must have an M.D. or Ph.D. degree and hold a tenure-track faculty appointment. Applications from coinvestigators with complementary expertise to work jointly on research projects are encouraged. If a collaboration permits access to field sites or laboratory resources unique to a tropical developing country, then the collaborative partner may be an international one, so long as the lead partner is a U.S. or Canadian researcher who meets the eligibility criteria.

Therapeutic Sciences

Clinical Scientist Awards in Translational Research

These awards are intended to foster the development and productivity of established independent physician-scientists who will strengthen translational research, the two-way transfer between work at the laboratory bench and clinical medicine. The awards provide $750,000 over five years ($150,000 per year). It is anticipated that up to 10 awards will be made annually. BWF is interested particularly in supporting investigators who will bring novel ideas and new approaches to translational research and who will mentor the next generation of physician-scientists. Proposed activities may draw on the many recent advances in the basic biomedical sciences—including such fields as biochemistry, cell biology, genetics, immunology, molecular biology, and pharmacology—that provide a wealth of opportunities for studying and alleviating human disease. Candidates generally must be affiliated with a medical school; candidates at other types of degree-granting institutions (including schools of veterinary medicine, public health, and pharmacy) will be considered only if they can demonstrate a plan for coordinating with institutions that provide the patient connection essential for translational research. Candidates must have an M.D. or M.D.-Ph.D. degree and hold an appointment or joint appointment in a subspecialty of clinical medicine. In exceptional circumstances, non-M.D. candidates will be considered if their work is likely to contribute significantly to the clinical enterprise; these candidates should hold an appointment or joint appointment in a clinical department. Candidates must be tenure-track investigators at the late assistant professor level or the associate professor level, or hold an equivalent tenure-track position, at the time of application. Candidates must present evidence of already having established an independent research career, as this is not a "new investigator" award. Individuals holding the rank of professor are ineligible.

New Investigator Awards in the Pharmacological or Toxicological Sciences

These awards are intended to foster the development and productivity of scientists early in their careers who will bring new ways of thinking and new experimental approaches to pharmacology or toxicology. The awards provide $210,000 over three years ($70,000 per year). It is anticipated that a total of 10 awards will be made annually. The awards are intended to give recipients the freedom and flexibility to engage in higher-risk research that holds potential for moving their respective fields in promising new directions. Candidates have considerable flexibility in proposing research activities, as both pharmacology and toxicology encompass broad areas. Indeed, BWF encourages candidates to define these fields in the broadest terms, so long as the proposed research has application to either the pharmacological or toxicological sciences. Candidates must have an M.D. or Ph.D. degree and be independent investigators appointed within three years of the application deadline to a tenure-track position as an assistant professor or its equivalent. Candidates need not hold appointments in established programs in pharmacology or toxicology; BWF encourages applications from researchers in such diverse departments and fields as biochemistry, genetics, molecular biology, and the physical and computational sciences. Professionals in clinical and veterinary departments who are engaged in fundamental research also are eligible to apply.

Reproductive Science

At least one of the Career Awards in the Biomedical Sciences is targeted to reproductive science annually. Qualifications for this award are outlined in the "Career Development of Scientists" section. In addition, BWF supports one postdoctoral fellowship annually for physician-scientists in obstetrics and gynecology. The award, which provides $144,000 over three years, is administered in partnership with the American Association of Obstetricians and Gynecologists Foundation (AAOGF); contact AAOGF for information (804/924-9921). BWF also provides partial support for one award annually to help obstetrician-gynecologists working in the basic reproductive sciences bridge the postdoctoral years and initial faculty years. The award is made through the Reproductive Scientist Development Program (RSDP), a consortium supported by the National Institute of Child Health and Human Development, professional societies, and foundations. (This program is open only to U.S. scientists.) BWF provides $240,000 over the first three faculty years, and RSDP supports the postdoctoral years. Contact RSDP for information (415/476-9047).

Interfaces in Science

Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences

These awards continue BWF's initiative to encourage the interdisciplinary training of promising graduate and postdoctoral students from the physical, chemical, and computational sciences so they can better apply their unique knowledge and talents to biological problems. The awards are intended to help increase the breadth of science perspective and education of individual scientists pursuing research in biological science, fostering their ability to understand, respect, and participate in the research paradigms of what traditionally have been other disciplines. Awards will be made approximately every two years, and BWF anticipates committing up to a total of $10 million for these awards during each award series. Awards will provide from $150,000 per year to $500,000 per year for five years. The goal is not to introduce more graduate and postdoctoral students into the research system, but rather to promote a different kind of training and a change in institutional behavior. Emphasis will be placed on supporting new programs or existing programs that will change graduate and postdoctoral training in a meaningful way, as opposed to programs seeking more funding for activities already under way. Several affiliated organizations within an institution may join together to submit an application. Consortia representing several institutions also may submit applications, so long as one academic institution is prepared to oversee the program and administer the grant. BWF has no bias concerning the proposed scientific focus of the interdisciplinary effort to be supported within an institution or consortium, expecting that each institution will capitalize on its unique scientific strengths and available resources. Past awards do not indicate a preferred emphasis for future awards.

Innovation Awards in Functional Genomics

These awards are intended to accelerate the integration of the vast amount of genetic sequence and expression data being generated in the world's laboratories into functional and clinically relevant information that will yield insights into mechanisms of human disease. Awards will be offered in two areas: animal model development and computational methods development. Awards for animal model development are meant to stimulate the development of innovative animal systems (primarily but not exclusively vertebrate) that capitalize on the availability of significant genome sequence data to model complex human genetic traits, or phenotypes, and disease. Proposals that forge collaborations between geneticists working on a model system and clinicians investigating therapeutic approaches to related clinical phenotypes particularly are encouraged. Awards for computational methods development are intended to stimulate the development of innovative theoretical and mathematical models that can be used to extract meaningful information from genomic sequence and expression data, as well as to synthesize the structural and functional data coming from different gene expression networks and model systems. Collaborative proposals encompassing experimental validation of theoretical models are encouraged. Proposals in both areas should focus on the modeling of complex multigenic traits, rather than on determining the functions of individual genes. BWF has committed $3 million to support from eight to 20 awards. Two levels of awards are offered in each area: $400,000 over a period of up to four years, and $200,000 over a period of up to four years. Candidates must have a Ph.D., M.D., or D.V.M. degree and hold a tenure-track faculty appointment. In addition to applications submitted on behalf of individual candidates, applications may be submitted on behalf of small groups of collaborators. *(BWF is evaluating this program to determine whether it will be continued after the 2000 award series.)*

Science Education

Student Science Enrichment Program

These awards are limited to nonprofit organizations in BWF's home state of North Carolina. BWF provides $1 million annually for this program, and awards provide up to $60,000 per year for three years. The program's goals include improving students' competence in science, nurturing their enthusiasm for science, and interesting them in pursuing careers in research or other science-related areas. The awards are intended to support projects that provide creative science enrichment activities for students in the sixth through twelfth grades who have shown exceptional skills and interest in science, as well as those who may not have had an opportunity to demonstrate conventional "giftedness" in science but are perceived to have high potential. The projects must enable students to participate in hands-on scientific activities and pursue inquiry-based avenues of exploration—an educational approach that BWF believes to be an effective way to increase students' understanding and appreciation of the scientific process. Project activities must take place outside of the usual school environment, such as after school, on weekends, or during vacation periods. Projects may be conducted all year, during the school year, or during the summer. Eligible organizations include colleges and universities, community groups, museums and zoos, public and private schools, scientific groups, and others that can provide experiential activities for middle school and high school students. BWF encourages partnerships—for example, between scientific groups and school systems or between universities and community groups. Industries may participate in collaboration with nonprofit organizations that assume the lead role.

BWF Visiting Professorships

These awards enable degree-granting institutions to bring in distinguished scientists whose interests relate to the basic medical sciences and the microbiological sciences. Professorships in the basic medical sciences are administered in partnership with the Federation of American Societies for Experimental Biology and the Canadian Federation of Biological Societies. Professorships in the microbiological sciences are administered in partnership with the American Society for Microbiology. Each year, up to 33 awards will be made in the basic medical sciences, and up to 10 awards will be made in the microbiological sciences. Awards provide $5,000, of which at least $2,000 must go to the visiting professor. Visiting professors will spend up to five days at the host institutions, where they will engage in teaching and discussion with students and faculty, as well as deliver a BWF Lecture on a subject pertinent to their discipline. Applications must be made by institutions wishing to host a visiting professor, not by an individual wishing to visit an institution. Nominees may come from the academic, government, or private sectors, so long as the nominees are distinguished researchers in their field. Applications are encouraged from institutions with predominantly minority enrollments, as well as from smaller institutions, newer institutions, and those located in less urban areas.

Environment for Science

These grants are intended to support activities focused on improving the environment for research. BWF makes noncompetitive grants for activities that fall outside of its competitive award programs but are closely related to its targeted areas, such as emerging infectious diseases or career development of scientists. BWF places special priority on working with nonprofit organizations, including government agencies, to leverage financial support for our targeted areas of research, and on encouraging other foundations to support biomedical research. Proposals should be submitted to BWF in the form of a letter, which should be no more than five pages. Applicants should describe the focus of the activity, the expected outcomes, and the qualifications of the organization or individuals involved; provide certification of the sponsor's Internal Revenue Service tax-exempt status; and give the total budget for the activity, including any financial support obtained or promised. Proposals are given careful preliminary review, and those deemed appropriate are presented for consideration by BWF's Board of Directors during one of its quarterly meetings.

PROGRAM APPLICATION DEADLINES

2001 Award Series

Career Development of Scientists	
Career Awards in the Biomedical Sciences	October 1, 2000
Life Sciences Research Fellowships	October 1, 2000
BWF Research Travel Grants	March 1/July 1/November 1 of each year
Emerging Infectious Diseases	
Scholar Awards and New Investigator Awards in Molecular Parasitology	January 15, 2001
Scholar Awards and New Investigator Awards in Molecular Pathogenic Mycology	January 15, 2001
New Initiatives in Malaria Research	January 15, 2001
Therapeutic Sciences	
Clinical Scientist Awards in Translational Research	September 1, 2000
New Investigator Awards in the Pharmacological or Toxicological Sciences	November 1, 2000
Reproductive Science	
Career Awards in the Biomedical Sciences	October 1, 2000
Obstetrics and Gynecology Research Fellowships	October 1, 2000
Reproductive Scientist Development Program Research Grants	October 1, 2000
Interfaces in Science	
Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences	April 10, 2000*
Innovation Awards in Functional Genomics	To be announced**
Science Education	
Student Science Enrichment Program	October 15, 2000
BWF Visiting Professorships in the Basic Medical Sciences	March 1, 2001
BWF Visiting Professorships in the Microbiological Sciences	March 1, 2001
Environment for Science	Received all year

** This is the application deadline for the 2000 award series. It is anticipated that awards in this program will be made approximately every two years.*

*** BWF is evaluating this program to determine whether it will be continued after the 2000 award series.*

Note: If a date falls on a weekend or holiday, the deadline is the next business day.

ADVISORY COMMITTEES

The Burroughs Wellcome Fund uses advisory committees for each competitive award program to review grant applications and make recommendations to BWF's Board of Directors, which makes the final decisions. Members of these committees are selected for their scientific and educational expertise in the program areas. In addition, BWF uses a financial advisory committee to help in developing and reviewing the Fund's investment policies. This committee is appointed by and reports to the Board of Directors.

Career Awards in the Biomedical Sciences

Mina J. Bissell, Ph.D.
Director, Life Sciences Division
Ernest Orlando Lawrence Berkeley National Laboratory

Pamela J. Bjorkman, Ph.D.
Associate Professor of Structural Biology
Howard Hughes Medical Institute Associate Investigator
California Institute of Technology

Patricia K. Donahoe, M.D.
Chief, Pediatric Surgical Services
Director, Pediatric Surgery Research Laboratories
Massachusetts General Hospital

Uta Francke, M.D.
Professor of Genetics
Howard Hughes Medical Institute Investigator
Stanford University School of Medicine

Elaine Fuchs, Ph.D.
Amgen Professor of Basic Sciences
Howard Hughes Medical Institute Investigator
University of Chicago

Phil Gold, M.D., Ph.D. (Cochair)
Executive Director, Clinical Research Centre
Montreal General Hospital
Douglas G. Cameron Professor of Medicine
McGill University Faculty of Medicine

Ashley T. Haase, M.D.
Professor and Chair
Department of Microbiology
University of Minnesota Medical School

Eric R. Kandel, M.D.
University Professor, Center for Neurobiology and Behavior
Howard Hughes Medical Institute Senior Investigator
Columbia University College of Physicians and Surgeons

Stanley J. Korsmeyer, M.D.
Director, Program in Molecular Oncology
Dana-Farber Cancer Institute
Sidney Farber Professor of Pathology and Professor of Medicine
Harvard Medical School

Martin M. Matzuk, M.D., Ph.D.
Stuart A. Wallace Professor of Pathology
Baylor College of Medicine

I. George Miller, M.D.
John F. Enders Professor of Pediatric Infectious Diseases
Professor of Epidemiology and Molecular Biophysics and Biochemistry
Yale University School of Medicine

Mary Lou Pardue, Ph.D.
Boris Magasanik Professor of Biology
Massachusetts Institute of Technology

Donald W. Pfaff, Ph.D. (Cochair)
Professor of Neurobiology and Behavior
Rockefeller University

Jerome F. Strauss III, M.D., Ph.D.
Luigi Mastroianni Jr. Professor
Director, Center for Research on Reproduction and Women's Health
University of Pennsylvania Health System

Ian A. Wilson, D.Phil.
Professor of Molecular Biology
Chair, Structure and Chemistry Affinity Group
Scripps Research Institute

James M. Wilson, M.D., Ph.D.
Director, Institute for Human Gene Therapy
University of Pennsylvania Health System

Hitchings-Elion Fellowships/BWF Research Travel Grants

Frank M. Huennekens, Ph.D.
Member, Emeritus
Department of Molecular and Experimental Medicine
Scripps Research Institute

Suzanne R. Pfeffer, Ph.D.
Professor and Chair
Department of Biochemistry
Stanford University School of Medicine

Jenny P. Ting, Ph.D.
Alumni Distinguished Professor of Microbiology and Immunology
Immunology Program Leader
University of North Carolina-Chapel Hill School of Medicine

Christopher Wylie, Ph.D. (Chair)
Harrison Chair of Genetics and Development
University of Minnesota

Hans H. Zingg, M.D., Ph.D.
Director, Laboratory of Molecular Endocrinology
Royal Victoria Hospital
Professor of Medicine
McGill University Faculty of Medicine

Adviser (ex officio) from the Wellcome Trust, BWF's sister philanthropy in the United Kingdom:

Mary Phillips, D.Phil.
Programme Manager
International Interest Group

Molecular Parasitology/Malaria

Stephen M. Beverley, Ph.D.
Marvin A. Brannecke Professor
Head, Department of Molecular Microbiology
Washington University School of Medicine

John C. Boothroyd, Ph.D. (Chair)
Professor and Cochair
Department of Microbiology and Immunology
Stanford University School of Medicine

Daniel G. Colley, Ph.D.
Director, Division of Parasitic Diseases
Centers for Disease Control and Prevention

Stephanie L. James, Ph.D.
Chief, Parasitology and International Programs
National Institute of Allergy and Infectious Diseases
National Institutes of Health

Chris Newbold, Ph.D.
Professor of Tropical Medicine
Institute of Molecular Medicine
University of Oxford

Kenneth D. Stuart, Ph.D.
Director
Seattle Biomedical Research Institute

Thomas E. Wellems, M.D., Ph.D.
Head, Malaria Genetics Section
National Institute of Allergy and Infectious Diseases
National Institutes of Health

Molecular Pathogenic Mycology

John E. Edwards Jr., M.D.
Chief, Division of Infectious Diseases
Harbor-UCLA Medical Center
Professor of Medicine
University of California-Los Angeles School of Medicine

June Kwon-Chung, Ph.D.
Head, Molecular Microbiology Section
National Institute of Allergy and Infectious Diseases
National Institutes of Health

P. T. Magee, Ph.D. (Chair)
Professor of Genetics and Cell Biology
University of Minnesota

Juneann W. Murphy, Ph.D.
George Lynn Cross Research Professor of Microbiology and Immunology
University of Oklahoma Health Sciences Center

Phillips W. Robbins, Ph.D.
Professor of Biochemistry
Center for Cancer Research
Massachusetts Institute of Technology

Clinical Scientist Awards in Translational Research

Martin J. Blaser, M.D.
Addison B. Scoville Professor of Medicine
Professor of Microbiology and Immunology
Vanderbilt University School of Medicine

Bruce A. Chabner, M.D. (Cochair)
Chief, Hematology and Oncology
Clinical Director, Cancer Center
Massachusetts General Hospital

Susan George, M.D.
Professor of Medicine and Pharmacology
University of Toronto Faculty of Medicine

Judith G. Hall, M.D.
Professor and Head
Department of Pediatrics
University of British Columbia Faculty of Medicine

Rochelle Hirschhorn, M.D.
Professor of Medicine and Cell Biology
New York University Medical Center

Charles A. Janeway Jr., M.D.
Professor of Immunobiology
Howard Hughes Medical Institute Investigator
Yale University School of Medicine

Barton A. Kamen, M.D., Ph.D.
American Cancer Society Clinical Research Professor
Cancer Institute of New Jersey
Robert Wood Johnson Medical School

Paul S. Lietman, M.D., Ph.D.
Director, Division of Clinical Pharmacology
Wellcome Professor of Clinical Pharmacology
Johns Hopkins University School of Medicine

John C. Marshall, M.D., Ph.D.
Arthur and Margaret Ebbert Professor of Medical Science
Director, Center for Research in Reproduction
University of Virginia Health Sciences Center

John E. Niederhuber, M.D.
Professor of Oncology and Surgery
Director, Comprehensive Cancer Center
University of Wisconsin Medical School

Judith L. Swain, M.D. (Cochair)
Arthur L. Bloomfield Professor and Chair
Department of Medicine
Stanford University Medical Center

Craig B. Thompson, M.D.
Scientific Director, Leonard and Madlyn Abramson Family Cancer Research Institute
Professor of Medicine
University of Pennsylvania Medical Center

New Investigator Awards in the Pharmacological or Toxicological Sciences

Pharmacological Sciences Panel

Lorraine J. Gudas, Ph.D.
Revlon Pharmaceutical Professor of Pharmacology and Toxicology
Chair, Department of Pharmacology
Weill Medical College of Cornell University

T. Kendall Harden, Ph.D.
Professor of Pharmacology
University of North Carolina-Chapel Hill School of Medicine

Lee E. Limbird, Ph.D.
Associate Vice Chancellor for Research
Acting Chair, Department of Pharmacology
Vanderbilt University Medical Center

Victor Ling, Ph.D.
Vice President, Research
British Columbia Cancer Research Centre

Palmer Taylor, Ph.D. (Cochair)
Sandra and Monroe Trout Professor and Chair
Department of Pharmacology
University of California-San Diego School of Medicine

Jeffrey M. Trent, Ph.D.
Chief, Cancer Genetics Branch
Scientific Director, Division of Intramural Research
National Human Genome Research Institute
National Institutes of Health

Toxicological Sciences Panel

Barbara F. Hales, Ph.D.
Professor of Pharmacology and Therapeutics
McGill University Faculty of Medicine

Philip Hanawalt, Ph.D. (Cochair)
Howard and Jessie Watkins University Professor
Stanford University

Victor A. Levin, M.D.
Professor of Neuro-Oncology
Bernard W. Biedenharn Chair in Cancer Research
University of Texas M. D. Anderson Cancer Center

Baldomero M. Olivera, Ph.D.
Distinguished Professor of Biology
University of Utah

Stephen H. Safe, D.Phil.
Sid Kyle Professor of Toxicology
Texas A&M University College of Veterinary Medicine

Thomas J. Slaga, Ph.D.
Executive Vice President, Research
AMC Cancer Research Center/Webb-Waring Antioxidant Research Institute

Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences

Robert L. Baldwin, Ph.D.
Professor of Biochemistry
Stanford University School of Medicine

Jeremy M. Berg, Ph.D.
Professor and Director
Department of Biophysics and Biophysical Chemistry
Johns Hopkins University School of Medicine

Jeffrey I. Gordon, M.D.
Professor and Head
Department of Molecular Biology and Pharmacology
Washington University School of Medicine

James Hudspeth, M.D., Ph.D. (Chair)
Professor and Head, Laboratory of Sensory Neuroscience
Howard Hughes Medical Institute Investigator
Rockefeller University

Douglas A. Lauffenburger, Ph.D.
Codirector, Division of Bioengineering and Environmental Health
Professor of Chemical Engineering and Bioengineering
Massachusetts Institute of Technology

Paul C. Lauterbur, Ph.D.
Professor and Director
Biomedical Magnetic Resonance Laboratory
University of Illinois at Urbana-Champaign

Tamar Schlick, Ph.D.
Professor of Chemistry, Mathematics, and Computer Science
Courant Institute of Mathematical Sciences
New York University

Michael S. Waterman, Ph.D.
Professor of Mathematics, Biological Sciences,
and Computer Science
University of Southern California

Innovation Awards in Functional Genomics

Russ B. Altman, M.D., Ph.D.
Associate Professor of Medicine (and Computer Science,
by courtesy)
Stanford Medical Informatics
Stanford University Medical Center

Aravinda Chakravarti, Ph.D.
James H. Jewell Professor of Genetics
Professor of Medicine
Case Western Reserve University

Allen Cowley Jr., Ph.D.
Professor and Chair
Department of Physiology
Medical College of Wisconsin

David R. Cox, M.D., Ph.D.
Professor of Genetics and Pediatrics
Codirector, Stanford Human Genome Center
Stanford University School of Medicine

Mark Fishman, M.D.
Professor of Medicine
Harvard Medical School
Chief of Cardiology
Massachusetts General Hospital

Terry Gaasterland, Ph.D.
Assistant Professor of Human Genetics
Rockefeller University

Philip Green, Ph.D.
Professor of Molecular Biotechnology
University of Washington

David Lipman, M.D.
Director
National Center for Biotechnology Information

Victor A. McKusick, M.D. (Chair)
University Professor of Medical Genetics
Johns Hopkins University School of Medicine

Janet Rossant, Ph.D.
Joint Head, Program in Development and Fetal Health
Samuel Lunenfeld Research Institute
University of Toronto Faculty of Medicine

Gary D. Stormo, Ph.D.
Professor of Genetics
Washington University School of Medicine

Science Education

Carolyn Blackmon
Past Education Department Chair
Field Museum

John E. Burris, Ph.D. (Chair)
Director and Chief Executive Officer
Marine Biological Laboratory

Charles Eilber
Education Consultant and President
Charles Eilber Associates Inc.

Samuel Houston, Ed.D.
Executive Director, Center for School Leadership Development
University of North Carolina

Elmima Johnson, Ph.D.
Staff Associate, Office of Assistant Director for Education and Human Resources
National Science Foundation

Shirley M. Malcom, Ph.D.
Head, Directorate for Education and Human Resources
American Association for the Advancement of Science

Gail Morse
Curriculum Integration Coordinator
Durant Road Middle School

Sally G. Shuler
Director for Development, External Relations, and Outreach
National Science Resources Center
Smithsonian Institution

Investment Committee

(The committee is composed of four members from outside BWF and two members from BWF's Board of Directors. The board's chair, BWF's president, and BWF's vice president for finance also serve on the committee as nonvoting members.)

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President
Advanced Investment Management

Mary Ellen Avery, M.D.
BWF Board of Directors

Stephen D. Corman (Chair)
BWF Board of Directors

Ronald Frashure
President
Acadian Asset Management

W. Curtis Livingston
Chair and Chief Executive Officer
Western Asset Management

Philip R. Tracy
Former President and Chief Executive Officer
Burroughs Wellcome Co.

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** Began service in October 1999*
*** Completed service in October 1999*

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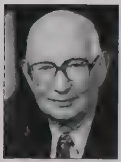
Harvard Medical School
Physician-in-Chief Emeritus
Children's Hospital, Boston

Enriqueta C. Bond, Ph.D.
President
Burroughs Wellcome Fund

Gail H. Cassell, Ph.D.
Vice President, Infectious Diseases
Drug Discovery Research and Clinical Investigation
Eli Lilly and Company, Lilly Research Laboratories

Stephen D. Corman*
Founder and former Chair and Chief Executive Officer
PharmaLink Inc.

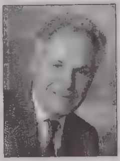


Henry G. Friesen, M.D.
President
Medical Research Council of Canada

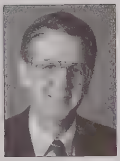
Samuel L. Katz, M.D. (Former chair)**
Wilburt C. Davison Professor and Chair Emeritus
Department of Pediatrics
Duke University School of Medicine

David M. Kipnis, M.D. (Chair)
Distinguished University Professor of Medicine
Washington University School of Medicine

I. George Miller, M.D.*
John F. Enders Professor of Pediatric Infectious Diseases
Professor of Epidemiology and Molecular Biophysics and Biochemistry
Yale University School of Medicine



Joseph S. Pagano, M.D.
Lineberger Professor of Cancer Research
Director Emeritus, Lineberger Comprehensive Cancer Center
University of North Carolina-Chapel Hill School of Medicine



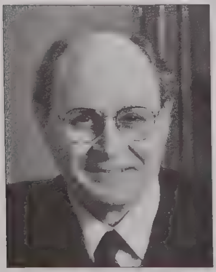
Philip R. Tracy**
Former President and Chief Executive Officer
Burroughs Wellcome Co.
Of Counsel
Smith, Anderson, Blount, Dorsett, Mitchell & Jernigan, L.L.P.

Jerry L. Whitten, Ph.D.
Professor of Chemistry
Former Dean of Physical and Mathematical Sciences
North Carolina State University

Jean D. Wilson, M.D.*
Charles Cameron Sprague Distinguished Professor of Biomedical Science
University of Texas Southwestern Medical Center-Dallas

IN MEMORIAM

Gertrude B. Elion, D.Sc. *(1918-1999)*
Gertrude B. Elion, a member of BWF's Board of Directors since 1991, died on February 21, 1999. Dr. Elion made numerous contributions to the advancement of science, and her work led to several life-saving medicines, including drugs to treat leukemia, herpes, and immunity disorders. Among her many honors, she shared the 1988 Nobel Prize in Physiology or Medicine for a series of scientific breakthroughs that revolutionized the world of drug design. "Gertrude Elion's love of science and keen interest in nurturing the careers of young scientists provided an incomparable match to the Burroughs Wellcome Fund's mission," says BWF President Dr. Enriqueta C. Bond. "Trudy helped our board assess new scientific opportunities for grant programs, and to so many of our awardees she was the supreme embodiment of a 'great' scientist and an inspiring mentor."



Daniel Nathans, M.D. *(1928-1999)*
Daniel Nathans, a member of BWF's Board of Directors since 1994, died on November 16, 1999. Among his many honors, Dr. Nathans shared the 1978 Nobel Prize in Physiology or Medicine for work using proteins called restriction enzymes to slice apart and analyze the genetic material DNA. His discoveries using these "biochemical scissors" are credited with helping to launch the ongoing revolution in molecular biology and genetic engineering that is producing numerous advances in medicine and other fields. "In his own quiet way, Daniel Nathans was a most influential member of our board," says Dr. Bond. "As but one example of his impact, Dan's visionary perception of the 'interconnectedness' of scientific disciplines was instrumental in leading BWF to develop our Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences program."

Executive

Left to right:
Enriqueta C. Bond, Ph.D., President
Scott G. Schoedler, Vice President, Finance
Martha G. Peck, Vice President, Programs

Finance, Administration, and Meetings

Bottom row:
Kenneth P. Browndorf, Senior Asset and Accounting Manager

Middle row, left to right:
Martie H. Gregory, Senior Manager, Office and Site Services
Judy McConnell, Librarian/Secretary
Betsy Stewart, Secretary
Israel D. Ehrisman, Technology Coordinator

Top row, left to right:
Jennifer Williams, Accountant
Sammy Carabello, Administrative Support
Glenda H. Oxendine, Administrative Assistant/Document Processing
Catherine L. Voron, Meeting Professional
Barbara J. Evans, Administrative Meeting Assistant

Programs and Communications

Bottom row, left to right:
Martin Ionescu-Pioggia, Ph.D., Program Officer
Victoria P. McGovern, Ph.D., Program Officer

Middle row, left to right:
Nancy S. Sung, Ph.D., Program Officer
D. Carr Agyapong, Senior Program and Communications Officer
Karyn Hede, Communications Officer

Top row, left to right:
Debra A. Linkous, Program Associate
Melanie B. Scott, Programs and Database Specialist
Jean A. Kramarik, Program Associate
Rolly L. Simpson Jr., Program Associate

CONTACT INFORMATION FOR MAJOR PROGRAMS

Staff e-mail addresses and program areas

D. Carr Agyapong, cagyapong@bwfund.org
Science education

Martin Ionescu-Pioggia, Ph.D., mionescu@bwfund.org
Career development of scientists, reproductive science

Victoria P. McGovern, Ph.D., vmcgovern@bwfund.org
Emerging infectious diseases, pharmacological or toxicological sciences

Nancy S. Sung, Ph.D., nsung@bwfund.org
Interfaces in science (including functional genomics), translational research

Jean A. Kramarik, jkramarik@bwfund.org
Emerging infectious diseases, pharmacological or toxicological sciences, environment for science

Debra A. Linkous, dlinkous@bwfund.org
Interfaces in science (including functional genomics), translational research, environment for science

Melanie B. Scott, mscott@bwfund.org
Science education, environment for science

Rolly L. Simpson Jr., rsimpson@bwfund.org
Career development of scientists, reproductive science, environment for science

To obtain information about programs

Burroughs Wellcome Fund
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www.bwfund.org

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